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Flexibility of railway vehicles on curves,

by H. LIECHTY, Bern.

Figs. 1 to 34, pp. 181 to 200.

Improvement in the running of railway rolling stock, especially on curves, is today a question of the greatest interest. During recent years it has been possible, on the basis of the laws of friction, to determine accurately the very complicated movements of axles on railway curves. It is inevitable that further time must elapse before these results become common property. Until then we must take it as a matter for congratulations when, at the same time, investigations on linked up axles — which in this connection are of particular importance — are undertaken, as these should result in important improvements and should confirm the results of theory in important points. The Author therefore welcomes the paper given below, on that account.

Reichsbahnrat Dr. Ing. BASELER.

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The increase in the capacity of vehicles has tended to give 4-wheeled vehicles greater longitudinal dimensions, on account of which the guiding pressure in relation to the wheelbase reaches a figure at which safe working is endangered, upkeep suffers and the maximum speed of groups of such vehicles cannot be further increased.

The steady increase of present-day traffic calls for a large increase in the speed of travel and transportation undertakings are forced to take all possible steps to reduce the duration of journeys.

The through speed can only be raised by increasing the maximum speed, by increasing the average running speed and by the reduction of the stopping time at stations. The maximum and average speeds of trains can be raised by the installation of more powerful motors and by the reduction of running resistance and further, if as a result of increased flexibility, it becomes possible to traverse curves at higher speeds. The stopping time at stations can be appreciably reduced by suitable arrangement of the entrances and exits of the coaches and by providing intercommunication between the individual coaches.

Seeing that the question of fitting more powerful motors has long been solved without any difficulty, the actual problems confronting us today are the

increase in flexibility on curves and the reduction of stopping time at stations.

This paper will deal specially with the increase of flexibility on curves and will touch shortly on some particular designs which have been worked out with a view to such increased flexibility.

2-wheeled bissels — or radial trucks — and 4-wheeled bogies have for a long time been in use to increase the flexibility of vehicles on curves and today the only new developments are those with respect to the control of the radial movements of axles and those for preventing the hunting of the 4-wheel bogie between the rails.

Efforts have been made to reduce the angle of impact by controlling the movements of the axle. By these means, limitation of the static guiding pressure (produced by the sliding side movement caused by the axle travelling at an angle) when the vehicle is entering the curve is achieved and this at once makes it possible to increase the wheelbase of the vehicle and to reduce the overhang. In this way again, the « dynamic » guiding pressure arising from the turning movement on entering a curve, which reaches a very high figure in the presence of large overhanging masses, is reduced (see fig. 2). These precautions permit not only of the desired increase in the maximum speed and of speed on curves, but, in addition, decrease the danger of derailment and the wear of both rails and wheels and therefore maintenance costs.

If therefore on account of the position of the pivot of the truck, whether in front or behind the axle, or if the truck is controlled by the draw and buffing gear or by a central axle, the axles are already radial on entering a curve, the guiding pressure and the angle of impact differ in different designs and are indeed smaller than in the case of the 4-wheeled bogie.

It is on these facts that the abandonment of the 4-wheel vehicle, which is becoming apparent in modern practice, is based and that opportunities are also given for dealing with the different features of the new designs. In this paper the design will only be dealt with in principle and details will only be touched upon when they are not clear from the illustrations.

Figures 1 and 2 show the increase in the guiding pressure in relation to reduction of curve radii and the increase in guiding pressure due to increased overhang of the vehicle.

Figures 3 and 4 show the design of a vehicle with 3 interconnected radial trucks. The pivots of the outer axles are placed in front of the wheels, while the center axle does not exercise any control on the outer axles but, carried in its own truck, merely supports the main frame.

Figure 5 shows a six-wheeled wagon by Algrain.

The two outer axles are carried in radial trucks, the pivots being *above* the axles, while the trucks are set radially by the lateral movement of the central axle, through the medium of longitudinal shafts and connecting rods. Figure 6 shows a similar design but with a four-wheeled truck in the center.

Figure 7 shows a six-wheeled vehicle designed by the Winterthur Works. In this vehicle the *pivots* are placed *directly behind* the axles, which are maintained approximately radial, by means of rods connected with the central axle. In this design the radius rod forms the casing which carries the cardan shafts

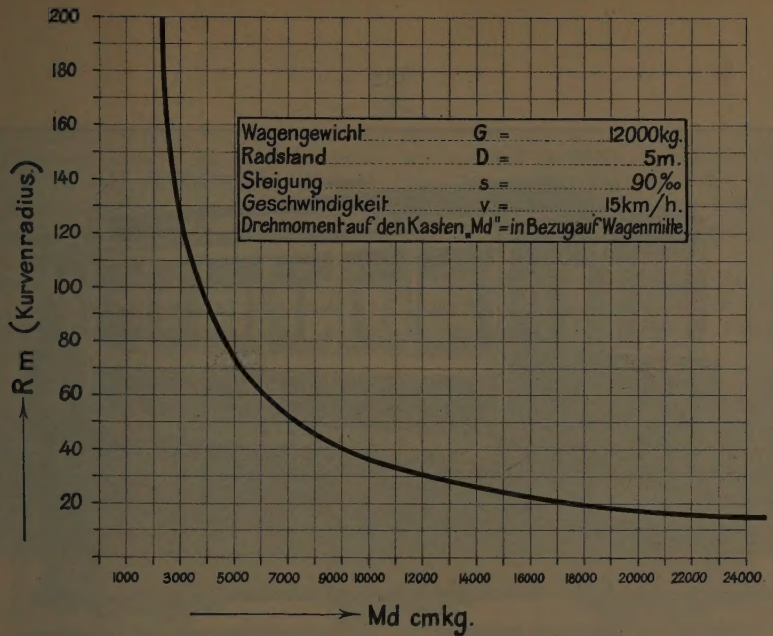


Fig. 1. — Increase in guiding pressure with reduction in radius of curve.

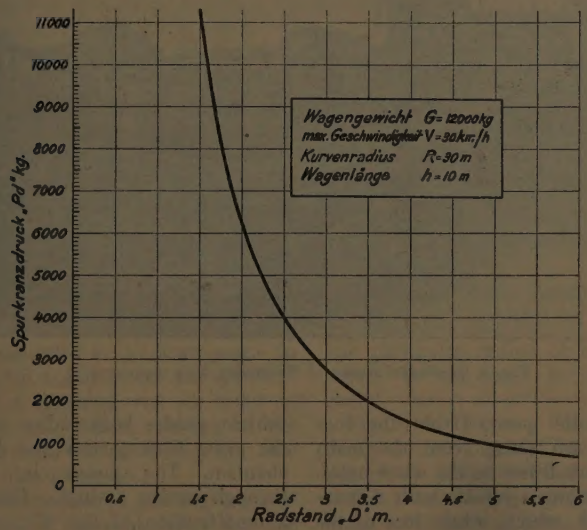


Fig. 2. — Increase in guiding pressure with increase of overhang.

Explanation of German terms in figs. 1 and 2 · Drehmoment auf den Kasten = Turning moment on the body about the vehicle center. — Geschwindigkeit = Speed. — Kurvenradius = Radius of curve. — Max. Geschwindigkeit = Max. speed. — Radstand = Wheelbase. — Steigung = Rising gradient. — Spurkranzdruck = Flange pressure. — Wagengewicht = Weight of vehicle. — Wagenlänge = Length of vehicle.

F'g. 3. — Motor-coach, Nurenberg type.

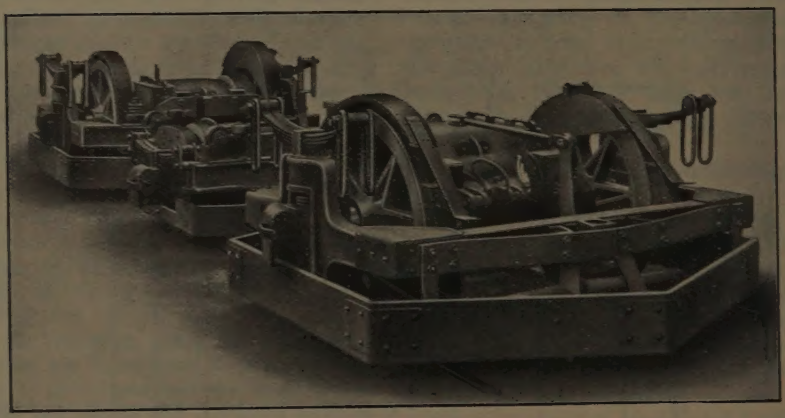


Fig. 4. — Radial trucks of Nurenberg type motor-coach.

transmitting the power from the motors, which are slung from the main frame in a sub frame to the outer axles.

Figure 8 shows a vehicle with a four-wheeled truck which, while free of the vehicle, guides both radius rods and at the same time carries the driving mechanism. The power is transmitted through cardan casings. This design is a modification of the Winterthur type.

Figure 9 shows a six-wheeled vehicle which, in contradistinction to the previous examples, has the *pivots* placed *behind* the axles, as they are actually central between each outer axle and the fixed center axle. Two diagonal rods connect the radial trucks with one another and compel the outer axles to take up a radial position on curves. These last three examples utilize the center axle for controlling the outer axles and can therefore only be built as six-wheelers.

Figure 10 shows the Nurenberg radial truck of a four-wheeled vehicle, which has the *pivot* placed *above* the axle and

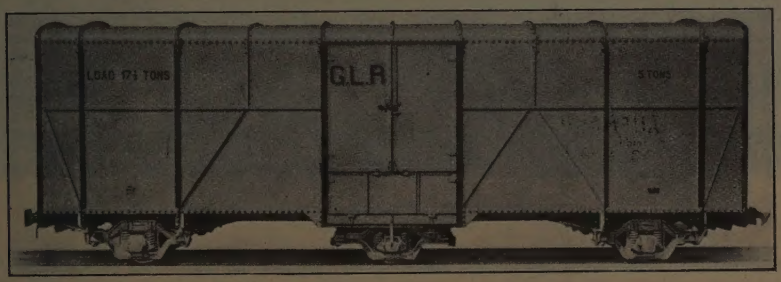


Fig. 5. — Trailer wagon with single axle center truck (Algrain design).

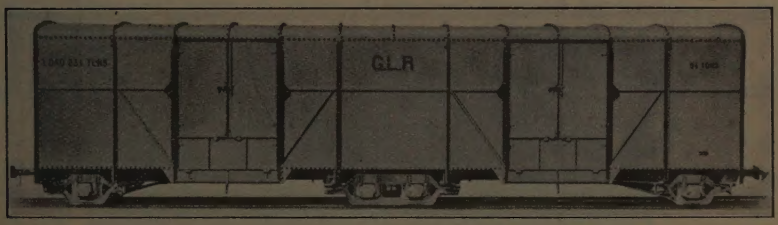


Fig. 6. — Trailer wagon with two-axle center truck (Algrain design).

which is connected to the draw gear. In addition, both radial trucks are interconnected by a diagonal rod in order to control the axle when running at the rear of a train as otherwise the axle might be incorrectly set.

With this method of placing the center there is the inherent defect that the truck will only be correctly placed for one particular radius of curve : on all others it will only be approximately radial.

Figure 11 shows a four-wheeled underframe of Liechty design wich has the *pivots* placed *behind* the axles, the radial trucks being connected with the draw and buffing gear. Check springs are provided which not only take up the

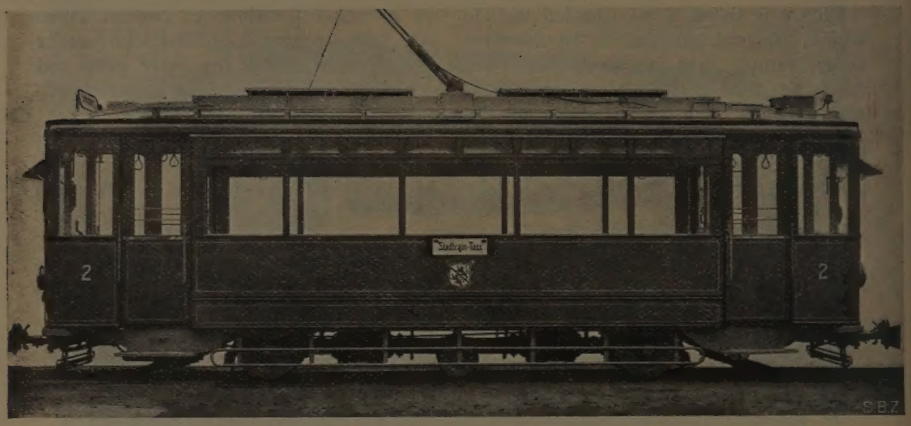


Fig. 7. — Motor-coach, Winterthur type.

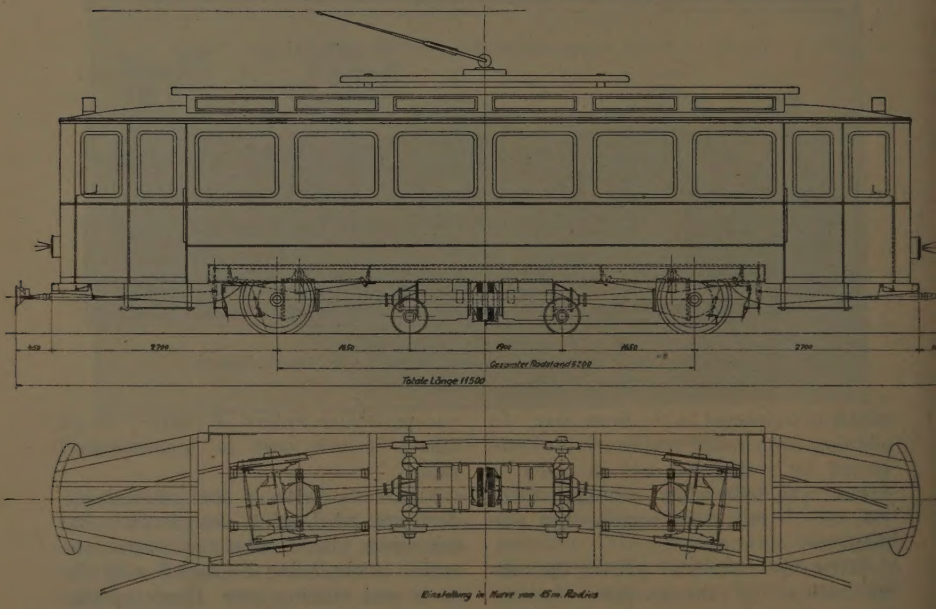


Fig. 8. — Motor-coach, Winterthur type.

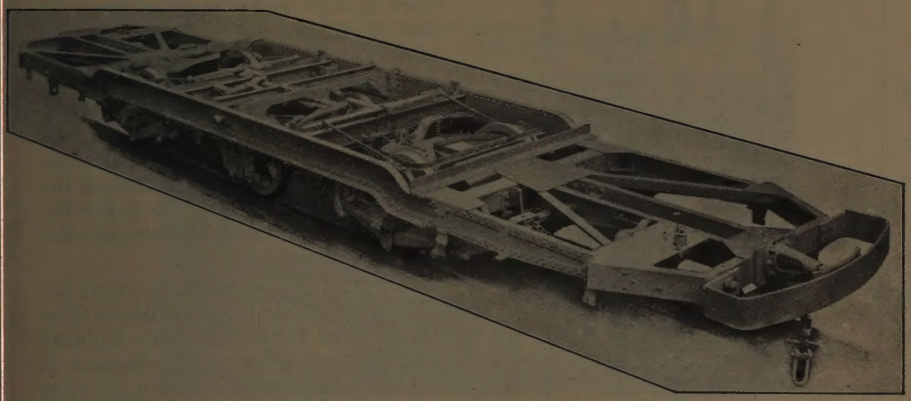


Fig. 9. — Motor vehicle, van Hacrens design.

side thrust but prevent hunting of the axles. The selection of a position behind the axle for the pivot, combined with correct design of the connections between the radial truck and the drawbar, ensure mathematically correct positioning of the axle on every possible curve.

Figure 14 (1) shows a similar radial

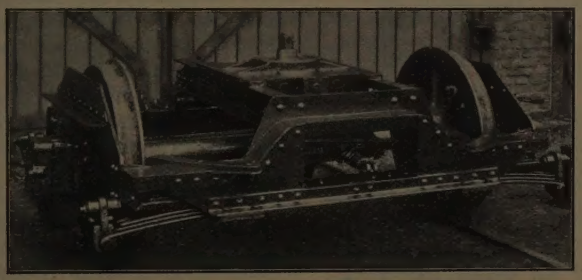


Fig. 10. — Radial truck, Nurenberg design.

truck for normal gauge vehicles with connection between the truck and buffing gear.

Illustration 15 shows a six-wheeled motor unit designed by Liechty, which can run without connection to the draw and buffing gear of another vehicle, as the outer axles are controlled by the fixed center axle. For this purpose two

(1) Figures 12 and 13 have been omitted at the request of the Author.

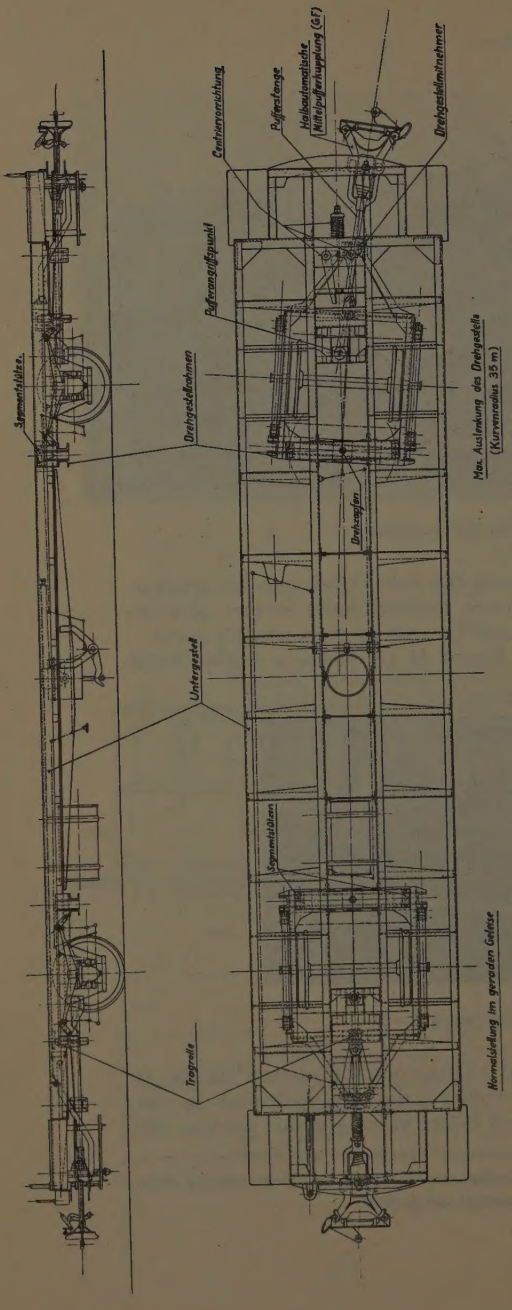


Fig. 11. — Underframe, Liechty design.

check springs, under equal tension, are used to control the movement of the trucks and to give the vehicle the necessary flexibility and smooth running when rounding curves. It will be noticed that the design is for cardan drive and that the point of connection of the cardan casing to the motor is used as the pivot of the radial truck, the power for the drive being transmitted through the casing.

The great importance of a radial position for the axle may be gathered from the fact that the German State Railways have found that the curve resistance of a vehicle falls by 65 % when its axles are set truly radial instead of in the usual manner and that metre gauge vehicles with a 6-m. (19 ft. 8-1/4 in.) wheelbase and with radially guided axles will run round a 25-m. (1 1/4 chain) curve in complete silence.

Four-wheeled bogies have not given the hoped for quiet running to the vehicles they carry and observation of the running of four-wheeled bogies has shown that the shorter the wheel base and the higher the speed, the greater the tendency to hunting and further that the amount of the weight and the position of the center of gravity thereof, are of great influence.

Figures 16 and 18 show various arrangements of electric motors in four-wheeled bogies, from which their influence on guiding pressure may be estimated. Figures 19-21 are of steam motor vehicles of different types; Winterthur has not hesitated to use an arrangement including overhanging weights, while flexible steam leads are obviated by carrying the steam through the bogie center pivots. In the Maffei design, on the other hand, placing the boiler installation on the bogie avoids

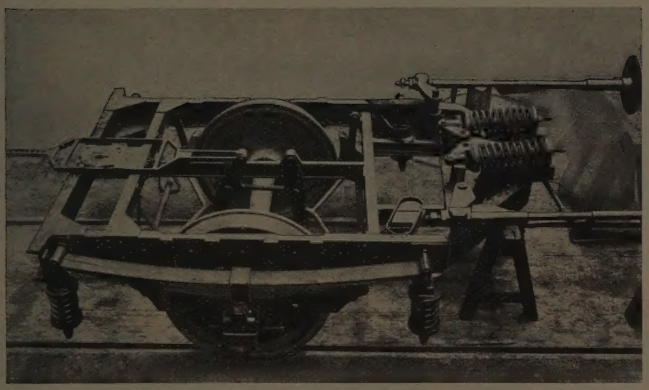


Fig. 14. — Standard gauge radial truck, Liechty design.

the necessity for flexible steam leads and the peculiar arrangement of the driving mechanism, brings the weight close to the center of gravity of the bogie, while in the Liechty design the axles are driven by an engine carried on the main frame of the vehicle and the weights of motor machinery on the bogie and flexible steam connections are both avoided. It should here be stated that keeping the driving engine and the boiler off the driving bogie permits the maximum speed being raised by some 40 % and shows an unexpected reduction in tyre wear.

Figure 22 shows a vehicle of Liechty design, with four-wheeled bogies, in which the axles are driven by electric motors carried on the main underframe, through the medium of hollow shafts. The power is transmitted to the coupling rods on the wheels through bevel wheels and layshafts on the bogies.

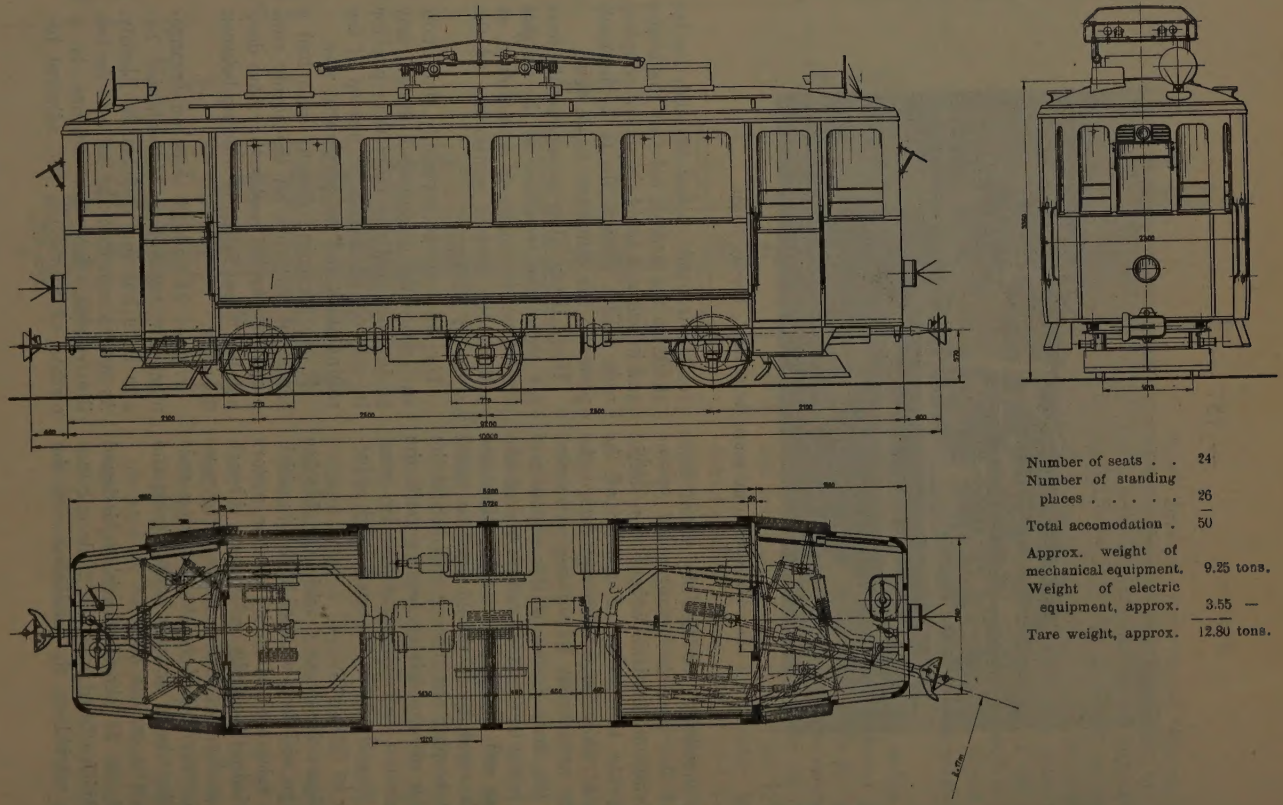
Figure 23 shows a vehicle designed by Winterthur, in which 2 electric motors carried on the underframe of the vehicle transmit power through cardan shafts to the nearest axles of the bogies and in order to avoid the use of coupling rods utilize cardan shafts to transmit power to the other two bogie axles.

These three latter arrangements have for object the reduction of the weights carried on the bogies to a minimum, as well as the correct positioning of the center of gravity.

The latter design, especially, shows how an apparently complicated design may be justified and can more than pay for its cost out of savings in upkeep of the rolling stock and the permanent way.

If the foregoing designs have had a beneficial influence on the steady running of 4-wheeled bogies, they have done nothing to put a stop to hunting between the rails.

Figures 24 and 25 show an arrangement for preventing four-wheeled bogies from hunting, designed by Liechty. As may be seen from the latter of the two illustrations, the new feature is a method of connecting two adjacent bo-



Number of seats . .	24
Number of standing places	26
Total accomodation .	50
Approx. weight of mechanical equipment.	9.25 tons.
Weight of electric equipment, approx.	3.55 —
Tare weight, approx.	12.80 tons.

Fig. 15. — Motor-coach with cardan drive, Liechty design.

Fig. 16. – Motor bogie with tram type motor between the axles.

Fig. 1 . — Motor bogie with two tram type m tors between the axles.

Fig. 18. — Motor bogie with two tram type motors outside the axles.

Fig. 19. — Steam coach, Winterthur design.

Fig. 20. — Steam coach, Maffei design.

Fig. 21. — Steam coach, Liechty design.

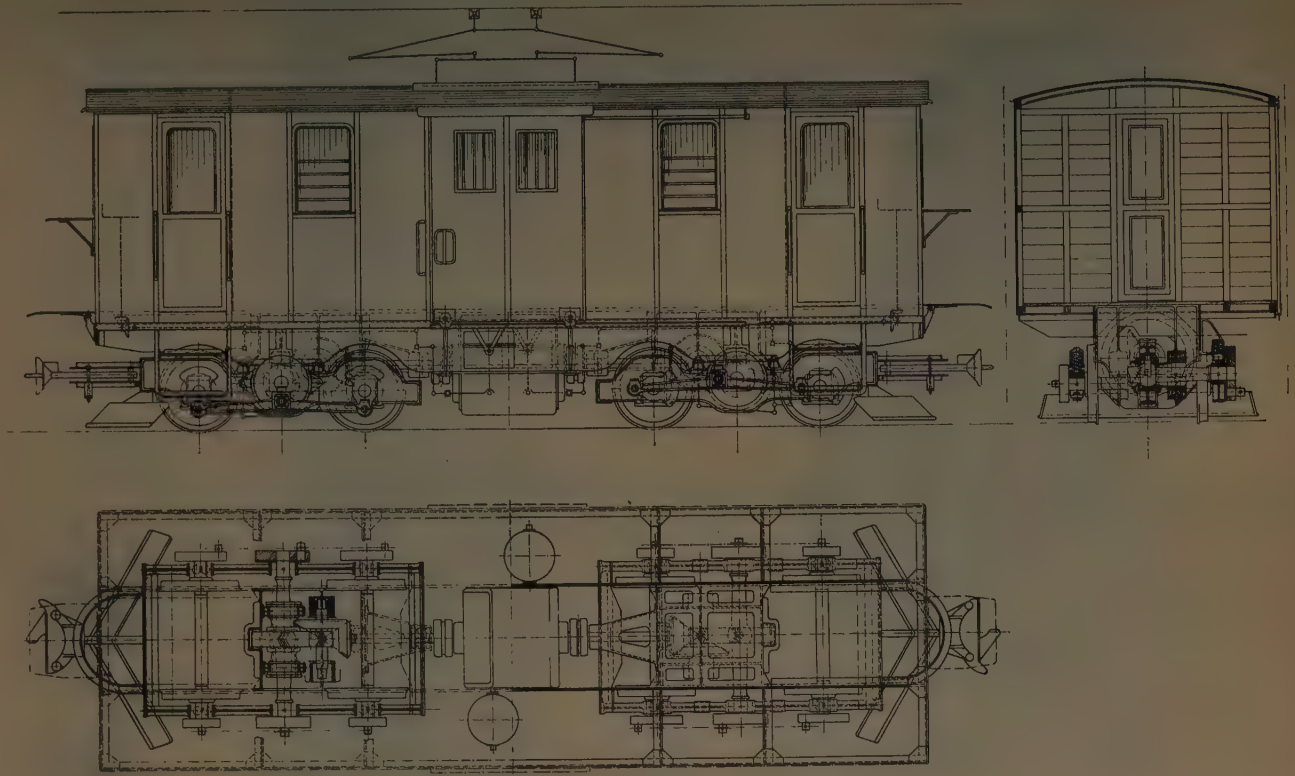


Fig. 22. — Motor-coach, Liechty design, with quill drive.

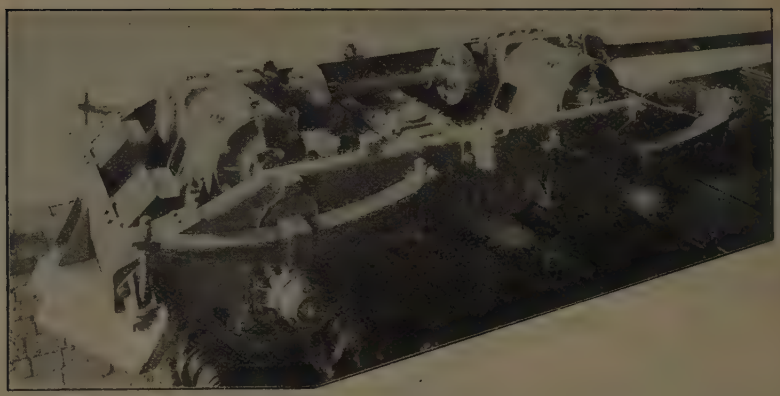


Fig. 23. — Motor vehicle with cardan drive, Winterthur design.

gies so that a guiding wheelbase is obtained many times greater than the wheelbase of one bogie only. The more the guiding wheelbase is increased, the more the hunting tendency is reduced. With this object in view the bogies are so connected by means of rods and levers with the buffers on the ends of their respective vehicles, that the bogies are not only prevented from adapting them-

Fig. 24. — Motor-coach with Liechty device to prevent hunting.

selves to curves but are made to take their proper position by the buffers. Auxiliary springs control the bogies against hunting when the vehicle is running at the end of the train and there is no following vehicle to prevent it.

Figure 26 shows a similar installation without equalisation of buffer pressure, and figure 27 shows one for central buffing gear.

None of these improvements, however, have so far taken into consideration the

difference of the wheel path travelled by wheels running on the inner and outer rails of a curve, which tends to set up longitudinal slip on the rails and, from the point of view of completeness, certain forms of construction will now be mentioned which deal with this point.

Figure 28 shows Algrain's differential axle, which obviates the frictional losses which occur through the unequal distance travelled by a pair of wheels fastened to a common axle.

Figure 29 shows the adhesion-and-rack drive axle of a locomotive with one fixed and one loose wheel, also designed to meet the unequal wheel path, with the object of reduction of curve resistance and the wear of wheels and rails.

Figure 30 shows a bissel axle with loose wheels.

All these new methods of construction indicate new ways for raising train speeds and increasing economy. In these forms however they will not be suitable for main line traffic because for that purpose it is not only vehicles, but complete trains, that are required, which not only must not be divided but which must also, as in the case of street railway vehicles, allow travellers to pass from one vehicle to another.

Figures 31, 32 and 33 show three different train formations made up of vehicles with Liechty radial trucks, which are in accordance with all modern requirements; all have driver's compartments only at the ends of the rakes and axle arrangement is such as to reduce the guiding pressure to a minimum. They are nevertheless not designed to give access from one vehicle to the other while running. The first to give such facilities are the articulated vehicles of Jakob and Liechty which are shown in figures 34-36.

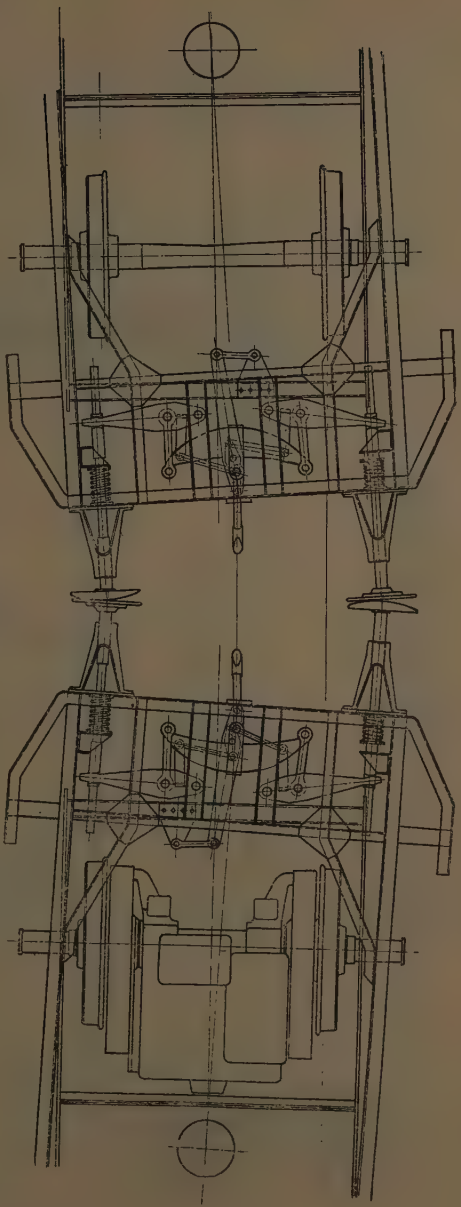


Fig. 25. — Liechty device to prevent hunting. Detail of motor-coach. fig. 24.

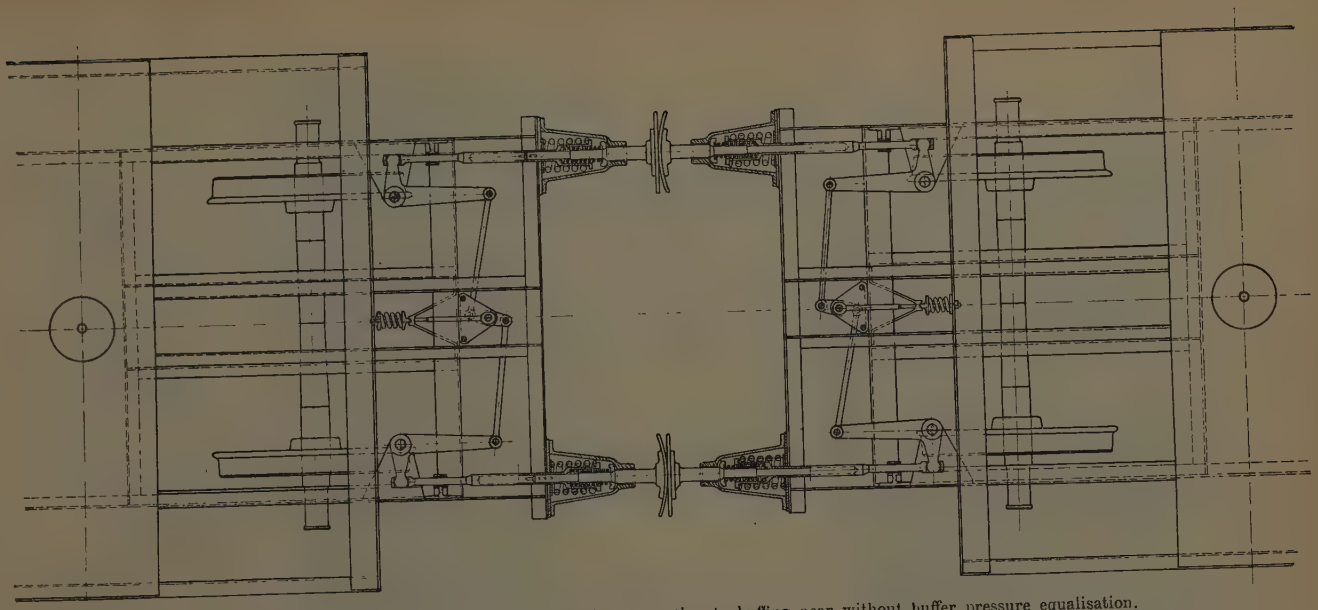
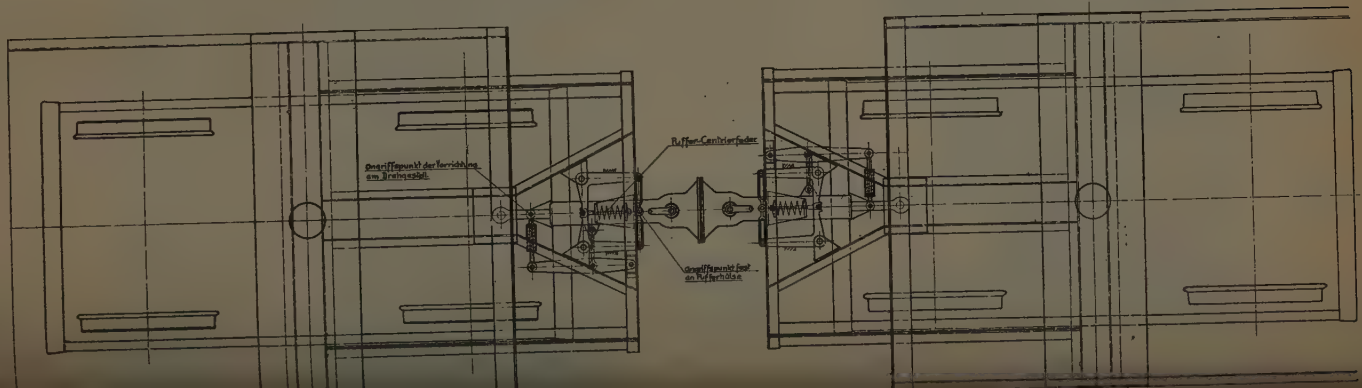


Fig. 26. — Liechty device to prevent hunting, for connection to buffing gear without buffer pressure equalisation.



The arrangement shown in figures 35 and 36 has the special object of reducing the number of axles per train of a given carrying capacity and thus making possible appreciable savings in first cost and maintenance charges.

In the first example, the outer axles are suitably controlled by connections

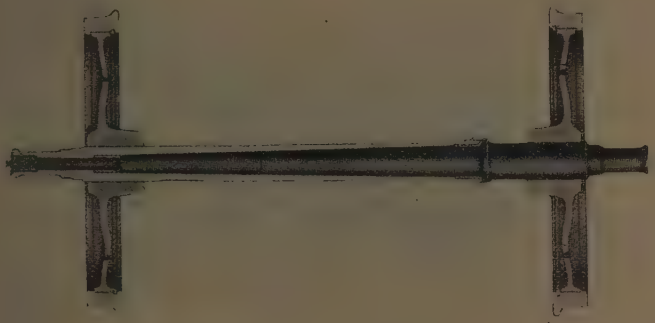


Fig. 28. — Algrain differential axle.

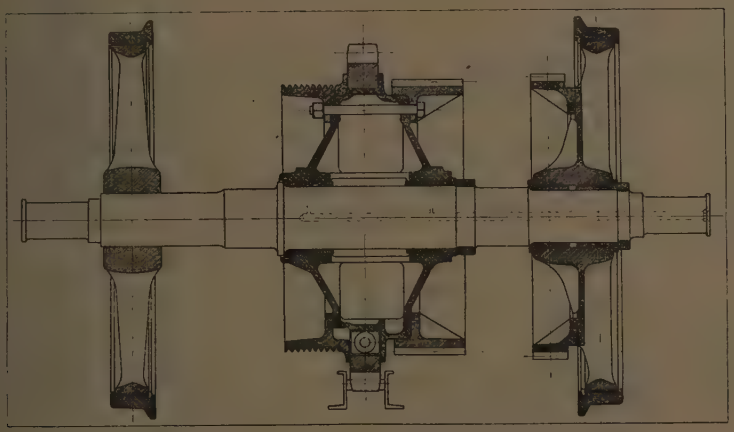


Fig. 29. — Driving axle with one loose wheel, Winterthur type.

from the center bogie, and in the latter example the Jakob bogie is replaced by a two-wheeled Liechty truck. In this last design control of the axles is obtained by double levers and connecting rods between the end axles and points on the carrying trucks.

It depends on the working conditions of the particular transport undertaking which design of vehicle and which for-

mation of train will give the best service.

In conclusion the following statement (fig. 37 will give an idea of the forces governing running on curves.

Corresponding to the calculated moment of inertia about the vertical centre axis of the vehicle, arrived at on the same bases for all vehicles, are the values

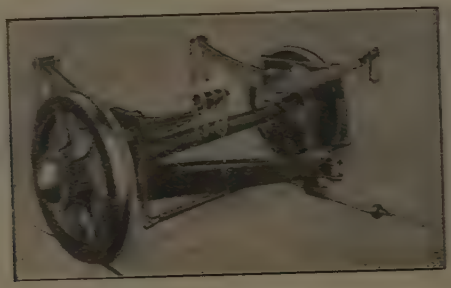


Fig. 30. — Bissel axle with loose wheels.

Fig. 31. — Two-coach train with radial driving axles, Liechty design.

for dynamic guiding pressure set up by the turning movement on entering curves.

Seeing that it is a matter of comparing designs, only the proportional figures are given in column 4 for this moment of inertia for the most unfavourable design (two bogies with motors outside the ends).

It must here be emphasised that the dynamic guiding pressure plays an important roll especially on sharp curves.

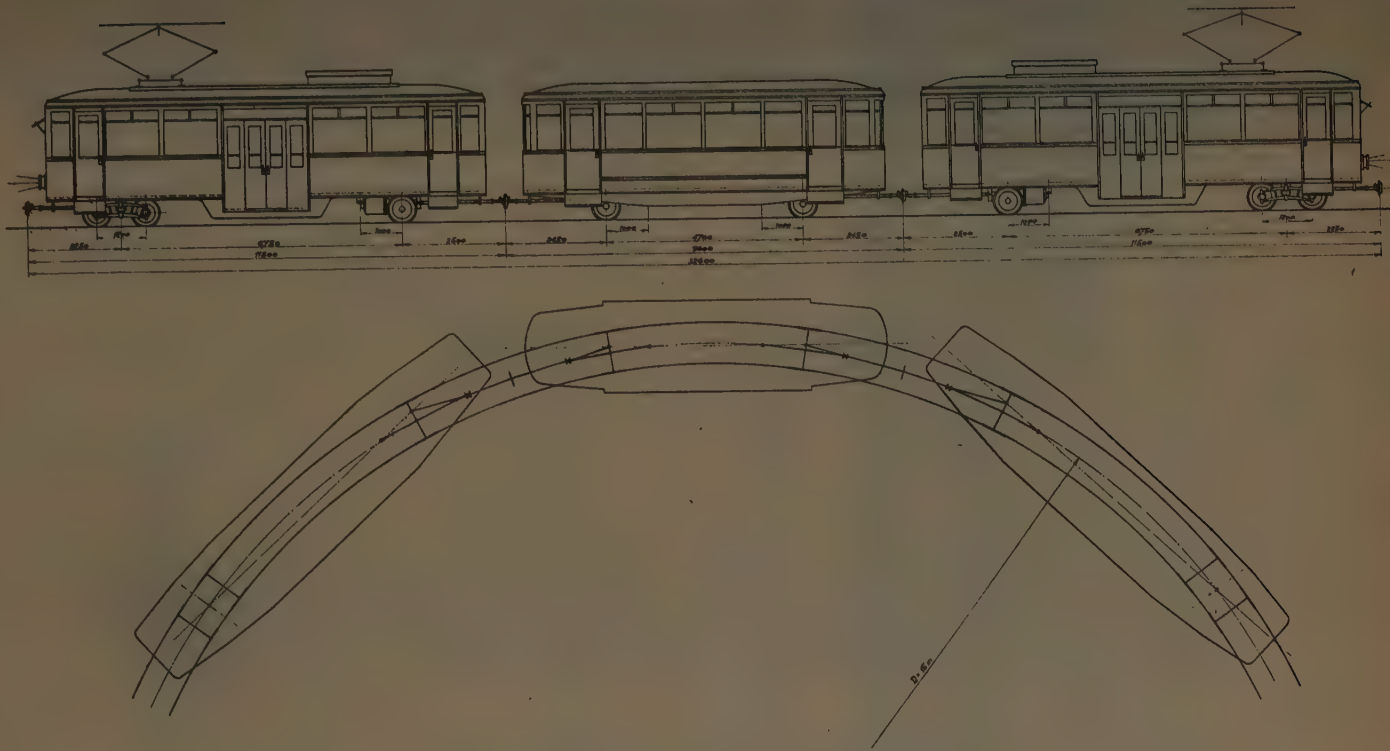


Fig. 32. — Three-coach train withradial axles, Liechty design.

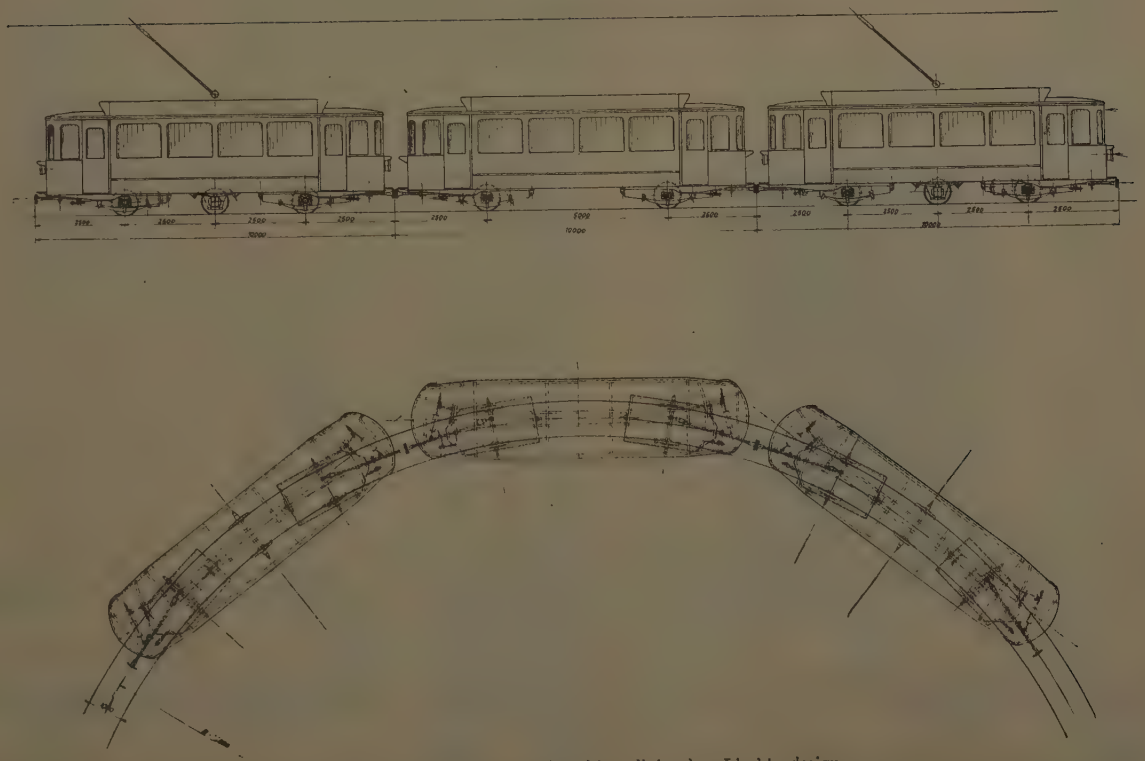


Fig. 33. — Three-coach train with radial axles, Liechty design.

It is possible to give the static guiding pressure for any axle for any angle of impact, with the greatest accuracy (c. 5).

This has, as comprehensive and accurate calculations show, whatever the angle of impact, always the approximate

Fig. 34. — Articulated coaches with six axles, Jakob design.

figure of $P = 2\,Qf$ (Q = wheel pressure, f = friction coefficient) which represents the force necessary to push the wheel-set

side-ways. This force increases correspondingly only to a small extent when a single axle is replaced by a four-wheeled

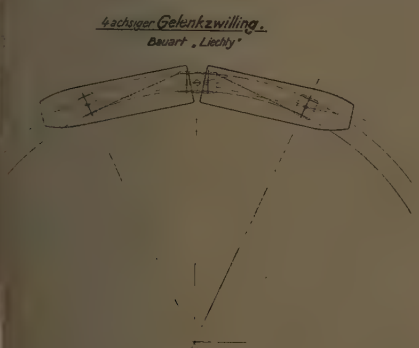


Fig. 35. — Articulated coaches with four axles, Liechty design.

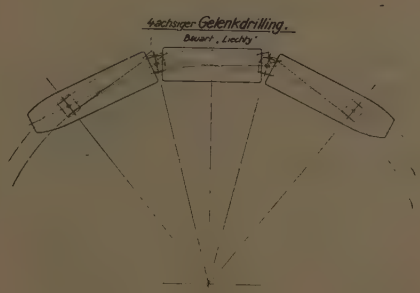


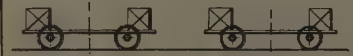
Fig. 36. — Articulated-coach train with four axles, Liechty design.

Explanation of German terms: 4-achsiger Gelenkzwilling, Bauart Liechty = 4-axle articulated twin, Liechty design. 4-achsiger Gelenkdrilling, Bauart Liechty = 4-axle articulated triplet, Liechty design.

bogie of normal design. In the case of radially positioned axles (angle of impact = 0) the guiding pressure practically disappears.

It may be observed from this exposition that it is possible by a suitable distribution of the mass in the vehicle and by guiding the axles, to reduce the above mentioned forces to a minimum.

Fig. 37. — Table of forces set up when running through curves.

Differences in guiding pressure **P**.					
1	2	3	4	5	6
No.	Arrangement of running gear.	Motor arrangement.	Text No.	P. dynamic.	P. static.
1		4 tram type motors outside the axles .	18	100 %	2 Qf.
2		4 tram type motors between the axles .	17	95 %	2 Qf.
3		2 tram type motors between the axles .	16	72 %	2 Qf.
4		Liechty, radial	—	47 %	0.
5		Shay transmission.	23	43 %	2 Qf.
6		Liechty hollow axle transmission. . .	22	35 %	2 Qf.
7		Winterthur cardan transmission . . .	14	21 %	2 Qf.
8		Winterthur cardan transmission . . .	13	17 %	2 Qf.
9		Liechty cardan transmission	15	17 %	0.

Q = Wheel pressure. — f = Coefficient of friction.

[621 .33 (.42)]

Railway electrification in Great Britain.

An historical and practical review of existing conditions,

by Roger T. SMITH,

B. Sc., Consulting Engineer, formerly Electrical Engineer, Great Western Railway

Fig. 1, p. 202.

(*Modern Transport.*)

In March 1920, the British Ministry of Transport set up an advisory committee to report on the adoption of a standard system of electric traction for the railways of Great Britain. This committee, under the chairmanship of sir Alexander Kennedy, reported in 1921, after hearing a great deal of evidence from European as well as British engineers and railwaymen. Their decision as to system was in favour of direct current, at a voltage of 1 500 at the substation busbars, for all new electrifications, including the extension of existing direct current electrifications. As sub-multiple of 750 volts, or a multiple of 3 000 volts, could be authorised by the Minister of Transport in case such voltages could be shown to be advantageous. At about the same time, France, Belgium and Holland had adopted 1 500 volts direct current as their standard for railway electrification. In 1927 the Ministry of Transport appointed a second Advisory Committee on Railway Electrification to review the recommendations of the previous committee, and to advise what modifications, if any, should be made in these conclusions already come to. In the meantime, some 445 miles of single track had been added to existing electrified railways, 8 1/2 % being extensions of tubes, or suburban systems, connected to the London Underground system, and the rest belonging to the Southern Railway. All these extensions had been electrified on the direct current system at 600/650 volts.

Suburban type electrified lines.

Under the Railways Act of 1921, 119 British railways had been formed into four groups, of which the Southern Railway had by far the larger share of electrified track. It found in the centre of its system 69 single-track miles of line — forming part of the former London, Brighton and South Coast Railway — electrified on the single-phase system at 25-frequency 6 600 volts. So inconvenient was this different system, wedged in between the former London and South Western system in the west and the former South Eastern and Chatham system in the east, that the Southern group decided to change the overhead single-phase to the third rail direct current system at 650 volts. This decision was taken before the Committee met. One other fact that the Committee had to consider was that only one length of line — the mineral line between Shildon and Newport on

(1) A paper read at a meeting of the « Société Française des Electriciens », Paris, 4 June. Mr. Roger T. Smith is a past-president of the Institute of Transport and of the Institution of Electrical Engineers.

the London and Nord Eastern Railway — with a route length of 18.6 miles and a single track length of 48.5 miles, had been electrified on the standard system at 1 500 volts direct current. This started working in 1915. Beyond this small portion of experimental main line, all the electrified railways in Great Britain are suburban railways, or of the suburban type, that is to say, railways radiating from a great city to its suburbs, with an intensive morning passenger service inwards to the city and an intensive outwards evening passenger

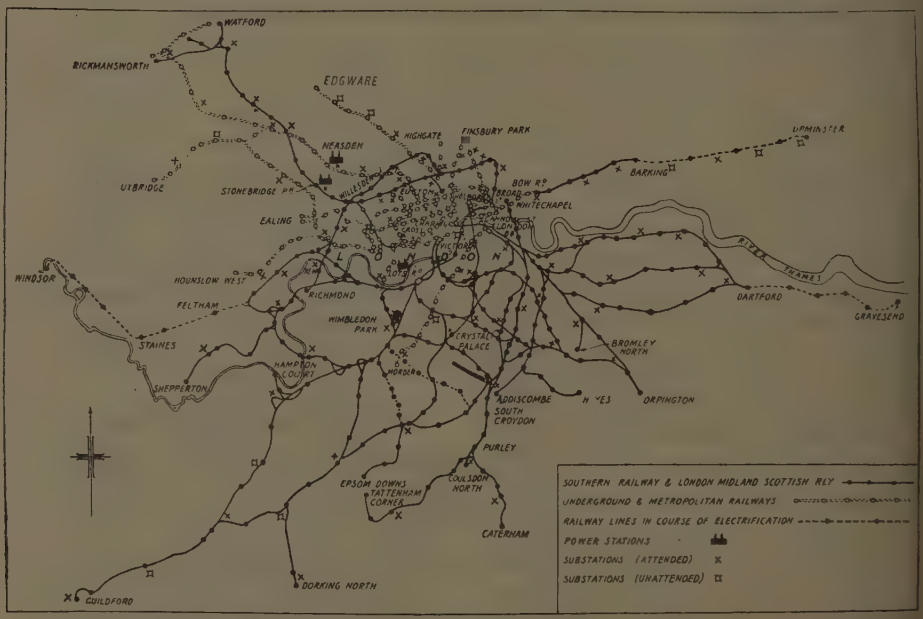


Fig. 1. — Sketch map shewing electrified railways and lines in course of electrification in the London area.

service from the city to the suburbs. Such a passenger service has been found all over the world to be best met by multiple-unit rolling stock, and, as this type of electric train is invariably used in an urban service, it is convenient for the purposes of this paper to group the electrification of urban and suburban railways, on which passenger service is either the sole or the predominating service, as multiple-unit stock electrification.

Advisory Committee's report.

The committee was, therefore, confronted with the fact that the only railway electrification which had taken place since the first report was issued in 1921, standardising 1 500 volts direct current, was an extension either of existing tube railways, or of suburban railways connecting with them, or an extension of lines already electrified, all using multiple-unit stock. It is true that on

the Metropolitan Railway (London) certain passenger and freight trains, arriving steam-hauled from outside, are, for convenience, hauled by electric locomotives to the terminus over the electrified track. No extensions had been made using the standard system at 1 500 volts, and there seemed no likelihood of any immediate main line electrification in Great Britain. The Advisory Committee on Railway Electrification, which reported (1) in the summer of 1928, therefore confirmed the standard of direct current at 1 500 volts; but, instead of making the lower voltage dependent on the consent of the Ministry of Transport, it also standardised 750 volts, leaving 3 000 volts to be applied for. In future, extensions or new railway electrifications are to be at either the higher or lower voltage of 1 500 or 750, and the fact that by far the greater part of the existing multiple-unit stock electrification is either at 600 volts — which is the urban voltage in London — or at 650 volts — for suburban work — is recognised by the recommendation that, while electric motors should be designed to give the best results at the voltage for which they have to work, all motors in future must be capable of working at 750 volts or at 1 500 volts as the case may be.

Current collection.

Overhead collection is standardised for 1 500 volts, with special approval by the Ministry for third rail collection where technical, structural, or economic conditions, having due regard to safety, justify its adoption. Uninsulated return by the running rails is specified. Third rail, with over-running contact shoe collection, is standardised for the lower voltage, with uninsulated return by the running rails. A fourth insulated rail for the return circuit may be permitted for tubes and for limited extensions of systems already using an insulated return. The position — relative to the running rails or to railway structures — of the overhead contact wire, or of the contact rail or rails, is specified to meet every condition so far found in practice.

Electric locomotives.

In connection with interchangeability of locomotives between different railways, a very complete survey of the railway structure gauges throughout England, Scotland and Wales was made for the Committee. British railways have been built up by the amalgamation of many separate companies owning short lengths of line, and as a result, the number of different loading gauges in the country, and, indeed, in each of the four groups and in the ungrouped railways, is embarrassing. While all the groups are limited to a maximum loading width of 9 feet, the maximum height differs between the groups and within the groups. Loading gauges for two different heights of electric locomotives were, therefore, prepared, and the lines over which they could be run, determined. Locomotives within a loading gauge 9 feet wide and 12 ft. 8 in. maximum height can run over 19 952 route miles out of a total of 20 216 miles; that is, over 98.7 % of the British standard gauge railways. Locomotives within a loading gauge 9 feet wide and 13 ft. 2 in. high can be worked over 13 327 route miles; that is, over 67 % of the total route. The smaller locomotive, which is really big enough for all purposes though somewhat cramped for fast passenger service, cannot be worked over 264 route miles, or 1.3 % of the whole. For all practicall purposes therefore, an electric locomotive capable of working all the British railway services on standard gauge lines can go anywhere structurally, so that only differing sys-

(1) Report of Railway Electrification Committee (1927). Ministry of Transport, published by His Majesty's Stationery Office, London.

Summary of length of railway and of trac

—	Great Western Railway.		London Midland and Scottish Railway.		London and North Eastern Railway.		Southern Railway.	
							Routes	
	Miles.	Km.	Miles.	Km.	Miles.	Km.	Miles.	Km
Electrified lines.								
Running lines : Route length . .	8.8	14.2	107.7	173 2	50.3	80 9	270	4
Running lines : Single track length.	17.8	28.7	225.0	362.0	110.8	178.3	710	1 1
Sidings : Single track length . .	2.5	4.0	26.0	42.0	18.1	29.2	40	
Total single track length electrified.	20.3	32.7	251.0	404.0	128.9	207.5	750	1
Electricity for traction.								
Total of one hour maximum demands on power station or on supply. . . . . kw.	3 570		Partly estimated. 40 650		Partly estimated. 6 300		75 0	
High voltage electricity generated or bought . . . kw.-hours.	13 318 700		135 427 000		15 620 683		270 550 4	
Train-miles per annum	1 006 478		6 798 860		1 138 675		17 827 0	
Train-kilometres per annum . .	1 620 725		10 941 405		1 832 470		28 689 0	
Ton-miles per annum	122 599 659		1 201 964 271		225 710 848		3 275 520 5	
Tonne-kilometres per annum . .	197 299 631		1 965 211 580		369 037 236		5 355 476 1	
Average working cost :								
Per train-mile (per train-kilometre)								
Per ton-mile (per tonne-kilometre)								

tems of electrification are a hindrance to complete interchange of electric locomotives. There are certain difficulties near rail level where locomotives are equipped for interrunning both with bows for overhead collection of current from contact wires and with shoes for collection from contact rails. These difficulties must be overcome by structural alterations.

trified in Great Britain at the end of 1929.

...on Underground ...ays (Metropolitan, ...strict, London ...ectric Tubes).		Metropolitan Railway.		Mersey Railway.		Liverpool Overhead Railway.		Totals.	
TRIFIED LINES.									
...es.	Km.	Miles.	Km.	Miles.	Km.	Miles.	Km.	Miles.	Km.
...7	131.4	39.4	63.4	4.8	7.7	6.5	10.5	569.2	915.3
...9	268.5	96.6	155.5	9.5	16.4	13.0	20.9	1 349.6	2 173.3
...7	72.0	16.8	27 1	2.3	3 7	13.7	22.1	164.1	264.1
...6	340.5	113.4	182.6	11.8	20.1	26.7	43.0	1 513.7	2 437.4
	91 200		35 700		2 470		1 300		256 270
	319 500 000		121 093 850		9 407 478		3 819 130		888 737 283
	17 826 537		6 777 770		507 345		729 417		52 612 129
	28 688 246		10 907 465		816 470		1 173 851		84 669 699
	067 517 969		1 040 281 292		64 772 770		35 741 433		8 034 108 837
	380 391 877		1 700 859 917		105 902 480		58 437 243		13 132 616 139

...ce. ...le.	Francs. Km.
46	14.8
96	0.123

Coal position in Great Britain.

Great Britain possesses — on the north-east coast of England, in Yorkshire and Lancashire, throughout the Midland Counties, and in South Wales and Kent and in several parts of Scotland — coal which, for the most parts, is of very good quality. Its export helps largely towards paying for Great Britain's imported food,

and its carriage accounts for about one-third of the freight revenue and one-fifth of the total revenue of our railways. In these circumstances, the coal traders naturally look to the railways to use the commodity which brings them so much revenue. The use for railway traction of electricity generated in power stations with coal-fired boilers demands, for a given tractive power, about half the amount of coal which would be burnt in the furnaces of steam locomotives. Where locomotive coal is imported, electric traction is a saving to the country whether water or thermal generated power is used; but, in a country where coal is so good and so abundant as to be exported, unless there is a saving in total expenses by electric traction and not only in coal, its use may offend the most important single customer — the colliery — by halving its sales to the railways for locomotive purposes. This trade difference between the electrification of railways in a country where electricity is produced wholly or largely by water power, and in a country where it is produced wholly by home-raised coal, must be taken account of, as one reason why no main-line electrification in Great Britain has as yet been carried out, quite independently of the price of coal.

Multiple-unit stock electrification.

As already mentioned, the Shildon and Newport mineral line, with 48.5 miles of single track, was the only piece of main line electrification in Great Britain at the end of 1929. This will not be true when, shortly, the electrified line between Manchester and Altrincham jointly owned by the London Midland & Scottish and the London & North Eastern Railways is opened. This section of main line, possessing 28 miles of single track, will be worked for passenger service with multiple-unit rolling stock. The track will be equipped with overhead contact wires worked at 1 500 volts direct current. All the electrified railways in Great Britain are in England, and, with the exception of the Shildon-Newport line, they are all of the multiple-unit stock passenger suburban type. The Metropolitan Railway, of London, however, is electrified as far north as Watford and Rickmansworth, as shown on the accompanying map, but continues from the latter point as a steam railway, jointly with the London and North Eastern Railway. Metropolitan Railway steam trains arriving at Rickmansworth or at Harrow change from steam to electric locomotives, and the trains are electrically hauled to the City over the Circle lines. Similar locomotive haulage occurs on the Metropolitan District Railway, London. In addition, a few freight trains hauled over the Metropolitan Railway by steam to the electrical boundary are taken over by electric locomotives to their terminus.

Electrified lines.

The sketch map (fig. 1) shows the electrified lines in the London area, this including the tubes and nearly half the underground circle with its branches, all owned by the Underground Electric Railways Company of London, Limited. The Metropolitan Railway is quite distinct, and owns, roughly, the upper half of the circle lines, while it runs from Baker Street out to Rickmansworth and beyond as a steam line. The Great Western Railway has a few miles electrified jointly with the Metropolitan Railway, and a few miles jointly with the Central London Railway. The London Midland & Scottish Railway's electrified lines in and around London, and the Southern Railway's electrified lines, are distinguished from each other in the sketch map by their position north and south of the Thames. Other electrified lines in Great Britain include those radiating from Liverpool belonging to the London

Midland & Scottish Railway, while there are also the Mersey Railway, which connects Liverpool with Birkenhead under the River Mersey, and the lines of the Liverpool Overhead Railway. In addition, there is the Lancaster, Morecambe and Heysham Railway, electrified as an experiment in single-phase by that company twenty-two years ago, as also the Manchester and Bury line, part of which was electrified originally at 3 600 volts direct current overhead, and is now electrified at 1 250 volts, using a contact rail with side contact for a vertical shoe on the motor coach. The London & North Eastern Railway Company's electrified lines include those in the Tyneside area, starting from Newcastle-on-Tyne, and the Shildon and Newport mineral line already referred to, both being electrified at 1 500 volts. In addition to the Southern Railway Company's lines shown radiating from London on the accompanying map, there is also the extension of the electrified lines from Purley to Brighton and Worthing on the Channel. The Southern Railway electrification is by far the most extensive of any railway electrification in England above ground, and the whole 710 miles of single track are now electrified on the direct current system at 650 volts, while the same system will be continued right down to the coast.

Unattended substations.

One reason for the adoption of this system is that the unattended substation has reduced the cost of working at so low a voltage as 650, although the substations cannot in general be more than 5.5 miles apart, and may have to be half that distance. An unattended substation may be either « fully automatic », which is to say that the approaching trains, through the drop in voltage they cause, start up the substation automatically, while the receding train, by the rise in voltage, automatically shuts it down again; or it may be « remote controlled », in which case attendants in one substation control the machinery, as well as every other function, in another substation or in more than one. On the other hand, it may again be « supervisory controlled », in which case one central control office commands the electrical working of a dozen or more unattended substations. In England we have a good many remote controlled unattended substations worked from attended substations. The capitalised value of the wages saved by an unattended-substation covers the increased cost of the automatic gear more than twice over. The general conclusions with regard to unattended substations, so far as English experience has gone, may be stated as follows :

Assuming automatic substations are used, with only one unit of plant in each, and that they are spaced sufficiently close together and with the single unit of sufficient capacity to work the full train service if one of them is out of commission, then ten such unattended substations will take the place of six attended substations designed to work the full service with one unit of plant out of commission. The first cost of the unattended substation scheme — including substation buildings, equipment, pilot cables and control equipment — will be from 10 % to 15 % higher than that of the attended substation scheme, but the annual charges — interest, depreciation, maintenance and operation — will be about 10 % in favour of the unattended substations. The substation losses are heavier for the unattended substations, but these losses are compensated for by the lower losses in the contact rail and in the track rail return, and in the extra elasticity in working due to the smaller voltage drop between substations.

Justification for low voltage.

It is obvious that a fully automatic substation, worked by the voltage drop

caused by the trains, cannot be worked above a certain density of traffic. Beyond that density, where the remote-controlled or supervisory-controlled sub-station comes in, the justification for using so low a voltage as 650 for, say, the 50 miles from London to Brighton, is not only due to the saving from unattended as opposed to attended substations, but also to the first cost and annual charges of the electrical equipment of the rolling stock. So much rolling stock has been equipped in England at 650 volts that this equipment has become standardised, and is much cheaper than 1 500-volt equipment. As a result, at the present time — largely owing to manufacturing conditions — it is economical to electrify quite long lengths of line at 650 volts direct current in England.

Extensions and new constructions.

The Finance Act of 1929 removed the passenger duty which had been imposed in 1842 as a percentage on certain passenger fares and services. The condition attached to this relief was that the greater part of the capitalised value of the passenger duty, as agreed with the Government, should be spent on improvements in the railway. It is this capital which is to be used by the Southern Railway in extending their existing electrification between London and Purley as far as Brighton and Worthing, which, as has already been mentioned, is to be carried out at 650 volts direct current, the economic reasons for this choice having been given. The Southern Railway have also in hand electrification extensions eastward from Dartford to Gravesend and westward from Feltham to Windsor. The present Government passed legislation which set up a Development Act Committee to assist with public funds the carrying out of important works which would increase employment. Under that scheme the London & North Eastern Railway are considering the electrification of 173 miles single track northwards out of London. The electrification of these lines presents many difficulties, some administrative and some engineering, and schemes have been under consideration for many years. It cannot yet be said that the scheme is likely to be carried out, though, if it does materialise, it will be electrified on the low-voltage direct current system. The London Midland & Scottish Railway are carrying out the electrification of the Manchester, South Junction and Altrincham line, which they own jointly with the London & North Eastern Railway. As previously mentioned, under main line electrification the single track mileage is 28, and the passenger service will be by motor coaches equipped with 750-volt motors to work in pairs in series on 1 500 volts, with overhead contact wire. The London Midland & Scottish Railway are also extenting north of the Thames in the east of London from Barking to Upminster. The Great Western Railway have no extensions in hand nor in immediate contemplation, but they are considering the possibility of running electric passenger services between London and Reading and London and High Wycombe. Both the London Underground Railways and the Metropolitan Railway contemplate small extensions to their electrified systems. All the above extensions, with the exception of the Manchester-Altrincham section, are at 600 or 650 volts, so far as is at present known.

Road transport and electrification.

Parliament has lately given the railways the right to run road transport, and the result has been a most satisfactory series of agreements, financial or working, between railways and road transport undertakings, both municipal and company, by which railways can, to a large extent, regulate the competition between road transport and rail transport.

While road transport undertakings are being bought up by railways, or working arrangements are being come to between them, it is too early to predict its effect on electrification; but as soon as the mutual working of road and rail transport in Great Britain has settled down, it seems likely that the electrification of lines purely to meet road competition will cease. Some branch lines will be shut down, and road transport will run the whole passenger service; but, so far, the railways have only dealt with passenger road service. Goods road services, in conjunction with railway services, have yet to be developed. England is not a hilly country in those parts where traffic is very dense, and, above all, it is a coal country, the collieries paying large sums of money to the railways in freight to the ports for export and for coal distribution for industrial and domestic use. Until many years of experience with the combination of road transport with rail has been obtained, it is hardly likely that schemes of main line electrification will have much chance of being undertaken. On the other hand, the Government, anxious to assist schemes which would provide employment, have set up a Committee on Railway Electrification for main lines, under the chairmanship of Lord Weir, to consider and report upon electrification on a large scale. The Committee is still hearing evidence, and if the report is favourable to electrification, both technically and financially, main line electrification will, no doubt, be further considered by the railways. Meanwhile, England carries more passengers electrically than any other country in Europe, and the chief mechanical engineers of the railways are working hard and successfully at the improvement in the design and efficiency of the steam locomotive.

[347 763 (.42) & 656.1 (.42)]

The Road Traffic Act, 1930 (Great Britain) [1],

by FREDERICK G. BRISTOW,

Member of Council, Institute of Transport.

(*Journal of the Institute of Transport.*)

The Road Traffic Act of 1930, the first really comprehensive measure for the regulation of motor vehicles since the early infancy of the motor car and a great legislative milestone, consolidating and bringing up to date the road traffic law, will affect not only traders, industrialists, agriculturists and all owners of motor vehicles, but in fact the whole community, since practically everyone now utilises road motor transport, either directly or indirectly.

It proved to be a herculean task for Parliament in its endeavours to harmonise the many interests involved in such a far-reaching and important piece of legislation, but the proper view to take and the one which was taken, was that which tended to promote all possible freedom of traffic on the highways and to diminish road accidents.

It may not be inappropriate briefly to refer to some of the circumstances leading up to the introduction of this measure in Parliament. The Locomotives on Highways Act of 1896 abolished the necessity for a red flag to be carried in front of a motor vehicle, and seven years later the Motor Car Act of 1903 (which was intended to be temporary and for three years only) was passed, authorising a speed limit of 20 miles per hour, and it is in accordance with the provisions of this Act and the regulations made under it that the motor industry has been governed to this day. It may fairly be claimed, therefore, that motor legislation is no less than a quarter of a century overdue, and this lack of up-to-date legislation to meet modern traffic conditions has for a long time seriously hampered both motor manufacturers and users.

In 1928 the Royal Commission on Transport was appointed, and the Road Traffic Act, which was introduced in the House of Lords in November 1929, is based substantially on the recommendations contained in the first two reports of this Commission.

The Act, which has been designated by the Minister of Transport as « a great charter for the ordered use of the King's highway », consists of no fewer than 123 clauses and 5 schedules and is divided into six parts which is indicative of the many and varied subjects which come within its purview.

It is so comprehensive that time will only permit of a very rapid bird's-eye view of those of its provisions which are of special interest and significance to the general body of road users, which may be grouped conveniently under the following main headings :

1. The licensing of drivers.
2. Speed limits.
3. Reckless, dangerous and careless driving.
4. Reduction of road accidents.
5. Compulsory third party insurance.

(1) Abstract of paper read before the Manchester-Liverpool and District Section of the Institute of Transport at Manchester, on 3 October 1930.

6. Highway code and road signals.

7. The regulation of motor omnibuses and motor coaches.

8. Traffic areas and Traffic Commissioners and

9. General regulations.

1. — The licensing of drivers.

The first material clause in the Act deals with the licensing of drivers. It re-enacts the old provisions of the 1903 Act in that any person on payment of 5 sh. will still be entitled to obtain a licence without undergoing any driving or mechanical test, but there is a new provision in regard to physical fitness.

Every applicant for a licence will, as from the 1 December, 1930, be required to make a statutory declaration that he is not suffering from any specified disease or physical disability which would be likely to cause his driving to be a source of danger to the public. If a licensing authority refuses to grant a licence, the applicant can claim to be subjected to a test as to his fitness to drive and if he passes such test and is not otherwise disqualified he will be entitled to secure a licence. Provision is also made for an appeal to a Court of Summary Jurisdiction by a person who is aggrieved by the refusal of a licensing authority to grant him a licence.

It will be seen, therefore, that whilst the clause aims at protecting the public against persons who are suffering from certain diseases or physical disabilities, drivers who can satisfy the authorities that their driving would not in fact be a source of danger to the public are fully protected.

The age of motor-cyclists has been increased from 14 years to 16 years, and motor-coach, motor omnibus and motor lorry drivers from 17 years to 21 years, but the age for motor car and motor van drivers remains unaltered at 17 years.

2. — Speed limits.

There was perhaps no more contentious part of the Act during its progress through Parliament than that relating to speed limits. It is universally recognised that the 20 miles per hour speed limit for motor cars and motor cycles has for many years not been observed or respected by motorists, neither has it been supported by the general body of public opinion. A great deal of discussion has centred round the desirability or otherwise of abolishing the speed limit for motor cars and motor cycles or the fixing of some arbitrary maximum limit of, say, 40 or 50 miles per hour.

The Royal Commission on Transport received exhaustive evidence on the subject and found that although the opinion of the authorities concerned, viz., highway authorities, police authorities, motorists and other users of the highway, including cyclists and pedestrians, was somewhat divided, the consensus of opinion was overwhelmingly in favour of no speed limit in the case of motor cars and motor cycles, it being felt that the interests of the public would fully be protected by the more adequate provisions and severer penalties against reckless and dangerous driving. Parliament adopted the recommendation of the Royal Commission in this respect and, from the 1 January, 1931, the speed limit for motor cars and motor cycles will be abolished, thus giving statutory recognition to a fact.

On the other hand, definite limits of speed are retained in the cases of other motor vehicles, viz., 30 miles per hour for motor omnibuses and motor coaches on pneumatic tyres and 20 miles per hour on solid tyres, and varying speeds for motor vans and motor lorries ranging from 30 miles per hour in the case of a motor van down to 8 miles per hour in the case of a motor lorry drawing a trailer. The Minister has power, however, to vary these limits of speed

by means of regulations without the necessity of applying to Parliament for a new Act.

3. — Reckless, dangerous and careless driving.

With the abolition of the speed limit one would naturally anticipate, as is the case, severer penalties to be imposed on drivers convicted for driving recklessly or in a manner dangerous to the public. The maximum fine for these offences on summary conviction is £50 or four months imprisonment for the first offence, and a fine of £100 and four months imprisonment for a subsequent conviction, with disqualification for holding a licence unless the Court thinks that there are special reasons for ordering otherwise.

A newer and lesser offence of careless driving is provided under the Act, viz., driving « without due care and attention or without reasonable consideration for other persons using the road », and the maximum penalty for the first offence is £20, and for a subsequent conviction £50 or three months imprisonment, but there is to be no disqualification for holding a licence in the case of a first or second conviction for this offence.

Adverse comment has been made on the fact that whilst no person can be convicted for exceeding the speed limit solely on the evidence of one witness, only one witness is required to prove the more serious offence of reckless, dangerous or careless driving.

An important innovation is that grants may for the first time be made from the Road Fund to police authorities towards the purchase, equipment and maintenance of motor cars and motor cycles for mobile police units, and it is earnestly to be hoped that the establishment of this new branch of the police force will result in a material diminution in the cases of reckless and dangerous driving which unfortunately are still to be met with on the highway.

4. — Reduction of road accidents.

Apart from the provisions which are directed against excessive speed, reckless, dangerous or careless driving, there are several other provisions framed with the object of eliminating or reducing accidents on the highway, *e. g :*

a) *Drunk in charge of a motor vehicle.* — The authorities take a very serious view, and one to which everybody will subscribe, of the offence of driving or attempting to drive a motor vehicle when under the influence of drink or drugs, to such an extent as to be incapable of having proper control of the vehicle, and an offender is liable to imprisonment for four months and a fine of £50, and to be disqualified for holding a licence for twelve months, with an increase in the penalty to £100 in the case of a subsequent offence. A police constable may arrest without warrant any person committing this offence.

b) *Restriction on pillion riding.* — Much discussion has taken place during the past few years regarding the practice of pillion riding in relation to public safety and the Act provides that a motor-cyclist may carry only one pillion passenger who must sit astride the cycle on a proper seat securely fixed behind the driver's seat.

c) *Limitation of drivers' hours.* — An important innovation is the regulation and limitation of the hours of work for drivers of commercial motor vehicles. No omnibus, coach, lorry or van driver will be permitted to drive for any continuous period of more than 5 1/2 hours or more than eleven hours in any one day, and there must be an interval of at least half an hour for rest and refreshment after each such continuous period. Any time spent by a driver on other work in connection with the ve-

hicle or its load is to be reckoned as time spent in driving.

d) *Stopping in cases of accident.* — In case of an accident involving damage or injury to any person, vehicle, or animal a motor driver is required to stop and give his name and address to anyone who has reasonable grounds for requiring it. If there is no other person available the driver is required to report the accident at a police station or to a police constable as soon as possible, and in any case within twenty-four hours of the occurrence.

e) *Taking a motor vehicle without owner's consent.* — A very necessary provision is that which makes it an offence for any person to take and drive away a motor vehicle without the consent of the owner, and a police constable may arrest without a warrant any person reasonably suspected by him of having committed such an offence.

f) *Footpaths and grass margins.* — A new duty is imposed upon highway authorities to provide, where they consider it necessary or desirable, footpaths by the side of roads for the safety or accommodation of foot passengers and adequate grass margins for the safety or accommodation of ridden horses and driven livestock.

5. — Compulsory third-party insurance.

The principle of compulsory third party insurance, which is at the present time being tried out in America, New Zealand and certain other countries, is a new and important feature of the Act, and these proposals are based very largely on the provisions of the New Zealand Act. It will be necessary, as from the 1 January, 1931, for every owner of a motor vehicle to take out a policy of insurance in respect of third-party risks and every driver will be required to carry a certificate of insurance and to produce it to any police constable when required. In the event of an accident involving personal injury to another person the driver must either produce his certificate to a police constable at the time or must report the accident at a police station within twenty-four hours of the occurrence and produce his certificate there. The certificate of insurance must also be produced when an application is made for a motor vehicle licence.

What effect this new provision will have on insurance premiums it is difficult to forecast but there would not appear to be any adequate reason for anticipating any immediate material increase. On the other hand, the issue of the highway code and the establishment of the mobile police force should ultimately reduce the number of accidents, resulting eventually, it is to be hoped, in lower insurance premiums.

The Act also provides that in the case of an accident involving bodily injury arising from the use of a motor vehicle on the road, the authorised insurer shall pay the expenses reasonably incurred by any hospital for the treatment of any persons so injured, to an amount not in excess of £25 per person, except where a charge has already been made by the hospital.

6. — Highway code and road signals.

A further important factor in the direction of safety will be the issue by the Minister of Transport, after consultation with the police and highway authorities, motoring organisations, pedestrians and others, of a Highway Code for the guidance of persons using the roads. A failure on the part of any person to observe the code will not be regarded as a criminal offence but the observance or nonobservance of any of its provisions can be pleaded in the Courts.

The code will no doubt follow generally the recommendations of the Royal Commission on Transport, which recom-

mended separate sections of the codes for :

a) drivers of motor vehicles (*e. g.* never overtake any vehicle at a blind point);

b) horses and horse-drawn vehicles (*e. g.* a man leading a horse keeps to the right of the road with the animal on the inside);

c) pedal cyclists (*e.g.* never ride more than two abreast);

d) pedestrians (*e.g.* before beginning to cross a street look first to the right and then to the left).

Power is given to the Minister of Transport to supervise the whole of the signalling of the highway, such as warning signs, direction posts, automatic traffic signals, etc., and no signs other than those conforming to the Minister's directions and erected by a highway authority will be permitted. All unauthorised signs are to be removed by the owner of the land on which they are erected, failing which the local authority is empowered itself to effect such removal. This provision, which will be welcomed by all road users, aims at standardising signals both as to character and design and the position in which they are erected.

7. — The regulation of motor omnibuses and motor coaches.

Many important and intricate provisions dealing with the licensing and regulation of public service vehicles, *i.e.*, motor omnibuses and motor coaches, but not tramcars, trolley vehicles and taxicabs, will come into force on the 1 April, 1931, the general effect of which is to safeguard the increasing number of the public who travel in these vehicles and to protect other users of the highway.

Apart from local legislation, the regulation of public service vehicles rests mainly on the Town Police Clauses Acts of 1847 and 1889 — measures which were passed before the days of the motor car and when the only vehicles to which they applied were horse cabs for journeys to and from railway stations. It is obvious, therefore, that the existing law is quite unsuitable to meet modern traffic conditions.

Under the Act public service vehicles are to be divided into three classes, *viz.:*

a) stage carriages, that is, motor vehicles carrying passengers at separate fares stage by stage and stopping to pick up or set down passengers along the line of route, such as motor omnibuses;

b) express carriages, that is, motor vehicles carrying passengers at separate fares between fixed points and not stopping to pick up or set down passengers along the route, such as motor coaches, and

c) contract carriages, that is, motor vehicles hired as a whole for a special journey, such as for a beanfeast or other outing.

8. — Traffic areas and Traffic Commissioners.

At the present time there are no fewer than 1 298 separate authorities in Great Britain authorised to issue licences in respect of motor omnibuses and motor coaches, and there are a large number of urban and rural areas with no licensing authority at all.

The Act provides for Great Britain to be divided into thirteen traffic areas, in each of which (with the exception of the Metropolitan Area) three Traffic Commissioners will be appointed, one of whom, the Chairman, will be a whole-time official appointed by the Minister of Transport for a term not exceeding seven years, and the other two will be appointed for a term not exceeding three

years, one from a panel of persons nominated by the local county councils and the other from a panel nominated by the local county boroughs and urban district councils.

To these Commissioners will pass the licensing powers at present vested in the existing local authorities who will cease to exercise these functions in so far as motor omnibuses and motor coaches are concerned. It will be one of the duties of the Commissioners to co-ordinate all forms of passenger transport in their areas and to make an annual report of their proceedings to the Minister of Transport.

Motor omnibus and motor coach owners will be required as from the 1 April, 1931, to take out a public service vehicle licence in respect of each of their vehicles. Before such a licence is granted the owner must secure a certificate of fitness, issued by a qualified certifying officer appointed by the Minister of Transport, and to ensure that the vehicles remain in a fit condition whilst in service; public service examiners are being appointed to make periodic inspections. By this means a national service of safety in the interests of the travelling public will be secured.

9. — **General regulations.**

The Minister has exceedingly wide powers under the Act to make regulations in respect of no fewer than between seventy and eighty subjects, including such diverse matters as :

a) the width, height and length of motor vehicles;

b) the emission of smoke;

c) the towing of vehicles;

d) the efficiency of brakes, steering gear and silencers;

e) excessive noise;

f) the use of skid pans and locking chains on horse-drawn vehicles;

g) the appliances to be fitted to pedal cycles, and

h) the removal of broken-down vehicles.

Before making such regulations, however, the Minister is required not only to consult with representative organisations, but also to lay the regulations before both Houses of Parliament, and if an address is presented to His Majesty by either House within twenty-eight days praying that any regulation shall be annulled, it shall thenceforth be rendered null and void.

[623. 258 (.42) & 656. 254 (.42)]

Frölich hydraulic car retarder system at Whitemoor Yard, London & North Eastern Railway (England).

Figs. 1 to 8, pp. 217 to 222.

(*Railway Signaling.*) (1)

The *Railway Gazette*, in a recent issue, described the car retarder system embodied in the new classification yard constructed by the London & North Eastern near Marsh, Cambridgeshire, England. Known officially as Whitemoor Yard, this installation is noteworthy as being the first classification yard in Great Britain to be equipped with the Frölich system of hydraulic car retarders, involving semi-automatic switch control and a number of other salient features.

Since Dr. E. Frölich, the inventor of this system, is a native of Germany, it is only natural that the German Railways were the first to use his system; it has, however, spread to several other European and South American countries. An article in the December 1925, issue of *Railway Signaling* dealt with the technical details of the retarder, which, therefore, will not be repeated here, except in so far as they bear especially on this installation.

The traffic handled by this yard consists partly of coal and general merchandise, shipped from points north, east and west of Doncaster, and destined for the eastern section of the London & North Eastern, and partly of similar ladings from the coal mines and yards on the Great Central section of the Nottinghamshire and Derbyshire lines, via London, as shown on the map. The new facilities satisfy a long-felt want in dealing more satisfactorily with the large volume of traffic.

Prior to the creation of this classification yard, four separate yards were utilized to deal with the traffic, one each at Peterborough East and Marsh, and two at Whitemoor. As these were constructed many years ago and are of very limited size, there developed from the inability to concentrate into direct train loads — a facility afforded by the new yard — an overlapping and duplication of services that made the work of classifying freight for some 350 destinations exceedingly complicated and expensive.

The following table is of interest in that it illustrates the separate capacities of the former yards and the new one at Whitemoor :

Yard.	No. of tracks.	Total car capacity.	Remarks.
Peterboro East.	13	780	Practically level shunting.
Whitemoor. coal	9	500	Hump shunting.
Whitemoor. merchandise . .	5	265	Level shunting.
Marsh.	13	655	Level shunting.
New Whitemoor yard . . .	40	3 311	Hump shunting.

Latter yard has also 10 receiving tracks of 80 cars capacity each.

(1) See also *Bulletin of the Railway Congress*. June 1929. pp. 726 et seq., and October 1929. pp. 2388 et seq.

Fig. 1. — A single retarder handles the heavest cars of coal.

Freight traffic facilitated.

The opening of the new yard brought about extensive changes in the then-existing freight channels. For instance, certain traffic from the Great Northern, previously routed via Peterborough, is now routed directly to Whitemoor via Sleaford and Spalding; the exception to this rule is in the case of coal from the Nottinghamshire and Derbyshire mines, which still travels via Peterborough.

Of the traffic still being routed via the London & North Eastern at Peterborough that for two-thirds of the destinations is « tripped » to Whitemoor for classification with other trains for the same points, thus creating a greater number of through train loads and reducing the number of intermediate stops to a minimum. The remaining one-third represents through trains from Peterborough to Norwich and Ipswich, and

Fig. 2. — Map showing strategic location of new hump yard at Marsh, Cambridgeshire.

also an occasional train to London. The extensive diversion of traffic already mentioned meant a complete remodeling of the scheduled train service from that area, and it was necessary to revise the operation extensively.

Design of the new yard.

The Whitemoor yard consists of 10 receiving and 40 classification tracks, and, in addition, has 4 other tracks : an engine track, a transfer track, a brake siding and a repair track. Trains enter the receiving tracks at the north end, and after being inspected and segregated, the cars are pushed over the hump by switch engines, a very powerful class being needed to perform this work. The type mainly used at present is the London & North Eastern three-cylinder 4-8-0 tank class. To assist the engineman in maintaining a constant speed, the locomotives are fitted with special low-register speedometers, the speed found most suitable in approaching the top of the hump being 2 miles per hour.

The hump is scientifically constructed, with the following gradients :

	Yards.
Approach :	
Level	63
Ascent :	
1 in 80	15
Level	8 1/3
First descent :	
1 in 18	50
Location of retarders.	
Descent :	
1 in 60	70
Level	93
Descent :	
1 in 200	233
Final :	
Level	350

At the foot of the hump there are four Frölich hydraulic car retarders, each of which controls a group of 10 tracks. These car retarders are operated by hydraulic power, the apparatus being controlled by two men in a specially constructed tower, a third operator manipulating a switch table, which controls the power-operated switches leading to the different classification tracks.

Switch operation control stored up.

When a train arrives in one of the receiving tracks, a switchman walks along the train, uncouples the cars, and makes out what is termed a « cut card ». On this card are indicated the numbers of the cars which have to be run off into the respective classification tracks. The cut card is sent by pneumatic tube to the control cabin, and the operator, on receipt of this, is able, by manipulating certain levers on the switch table, to store up the route movements electrically, in a drum on the floor below. The cars, in passing down the hump and through the retarders, automatically set the points for succeeding cars, this being done by means of track circuits, in accordance with the routes previously stored in the switch drums. Four-aspect color-light signaling, at the top of the hump, has been adopted to indicate the speed at which the cars must be humped, while in foggy weather Klaxon horns are utilized, the operation then being governed by sound signals.

In the event of any special cars passing over the hump, or other circumstance arising, of which the yardmen should be informed, a megaphone is used from the control tower. The foreman's cabin at the top of the hump is in telephonic communication with the cabin at the entrance to the receiving yard, and with the control cabin; the foreman, from his position at the top of the hump, is able to exercise a general jurisdiction over the entire operation. The yard is illuminated at night by means of floodlight projectors.

Electric motors situated in the basement of the control tower drive the

pumps generating hydraulic pressure for working the retarders, and heating pipes are provided underneath these retarders to prevent freezing in severely cold weather.

Improved results.

The provision of these retarders, together with the new method of operating the switches leading from the hump to the classification yards, has speeded up the classification to such an extent that a train of 70 cars, with from 40 to 50 cuts, is classified in 7 minutes, the sequence of the movements over the hump being much quicker than can be undertaken with safety in a yard dependent solely upon brakemen for the application of the brakes on the cars to regulate the speed. The following are interesting particulars taken from a typical day's work at Whitemoor :

Train of 62 cars with 43 cuts in 7 minutes.
Train of [illegible] cars with 46 cuts in 7 —
Train of 54 cars with 37 cuts in 6 —
Train of 52 cars with 31 cuts in 6 —
Train of 34 cars with 26 cuts in 5 —

In a shift of 8 hours, 1 369 cars were classified, this involving 962 cuts. These figures serve to demonstrate very clearly the expedition with which the trains are sorted, and the saving effected by concentrating the switch movements as described.

Method of working in the classification tracks.

The new yard with its 40 classification tracks is in effect divided into three sections, *i. e.*, the east section, the middle or main section, and the west section. In each of these sections trains of a distinct nature are made up ready for departure. The cars which are shunted into the center groups of tracks, numbered 11 to 31, form through loads to other sorting and delivery yards on the eastern section ; Norwich, Spitalfields, Ilford, Angel Road, Cambridge, etc.

The east side of the yard is assigned to the « country » traffic — that is, the traffic for all small stations situated between Whitemoor and the large centers. Into each of these nine sidings (Nos. 32 to 40, inclusive) traffic is classified for the various stations on branch lines or sections of the main line, the amount of traffic for which does not warrant a through train. It is obvious that in order to facilitate work en route, the cars must be made up in the train in the order in which they are to be detached, and the special facilities provided at Whitemoor for this purpose may be described as follows : Connecting with the lower end of the nine tracks is a long classification spur constructed in the form of an auxiliary hump, and when a train is being classified, the desired number of cars is drawn by the switch engine from the track and over this hump. The cars are then sorted back into the correct sections in the sidings, one switchman detaching the various cuts as they are pushed back over the crown of the auxiliary hump by the engine, while another man manipulates the hand-throw switches to direct the cars into the required track. The various sections are then coupled together when the train is ready to leave. The gradient of this auxiliary hump is 1 in 20 for the first 25 yards. This effects a quick clearance of cars, and with an active man throwing the switches, a train can very quickly be classified. From 12 to 18 trains are made up in this way every 24 hours.

On the west side (sidings 1-10) the work is of a more simple character. The trains on this side of the yard are all made up in two sections; *i. e.*, a Bury St. Edmunds train consists of Bury town traffic next the caboose, and Bury district traffic next the engine. The sections of an Ipswich train are (1) Ipswich

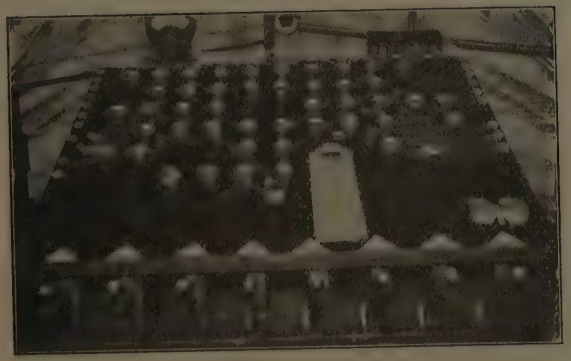


Fig. 3. — This unique control panel is a schematic model of the classification yard.

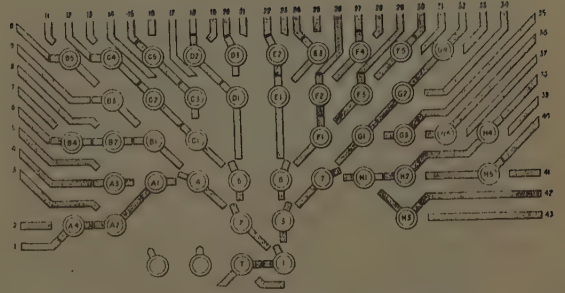


Fig. 4. — A diagram of the control machine (fig. 2).

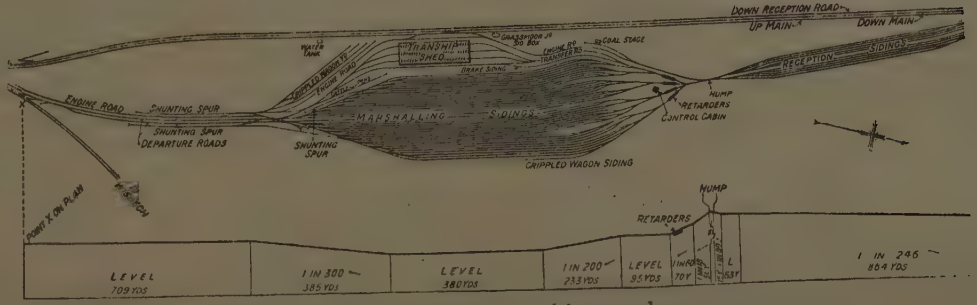


Fig. 5. — The receiving and hump yards.

town traffic; and (2) Ipswich branch-line traffic, the arrangement being as follows : Traffic for the various rear sections is switched direct from the receiving tracks over the hump into the tracks allocated for those trains, while that for the various front sections is also classified into a « feed » or « common » track, from which it is drawn into a switch spur at the lower end of the yard, the various cars then being switched back into the train for which they are intended.

Train departure.

Having described the various methods by which trains are prepared in the tracks, it will be of interest to note the procedure adopted in connection with their departure from the yard. At the point where the 40 classification tracks converge to form the two departure tracks there is an inclined brake siding or « kip » with connections to both departure tracks. All the cabooses of trains which arrive at the receiving tracks are worked through the yard and placed as

Fig. 6. — Retarder is hydraulically operated.
Note the masonry foundation.

opportunity arises on the kip, which will accommodate 15 cabooses. The kip is constructed with a gradient sufficiently steep towards the departure end to enable a caboose, when released, to run by gravity to the rear of its train. As soon as the conductor arrives in the yard he is given the number of the engine that is to haul the train, the particular caboose that is to be attached to the rear of it, and the number of the track from which it is to be drawn. He thereupon proceeds to the track, and examines and attaches the requisite number of cars. The engine is coupled up as soon as it arrives from the roundhouse, and the conductor signals to the switchman that the train is ready to be drawn into the departure track to attach the caboose. This is done as quickly as possible, and as soon as the last car of the train is drawn clear of the brake kip points, the caboose is released and runs to the rear of the train, the latter then being ready to accept the signal for the main line. As the train is being drawn through the departure tracks, which are approximately 560 yards in

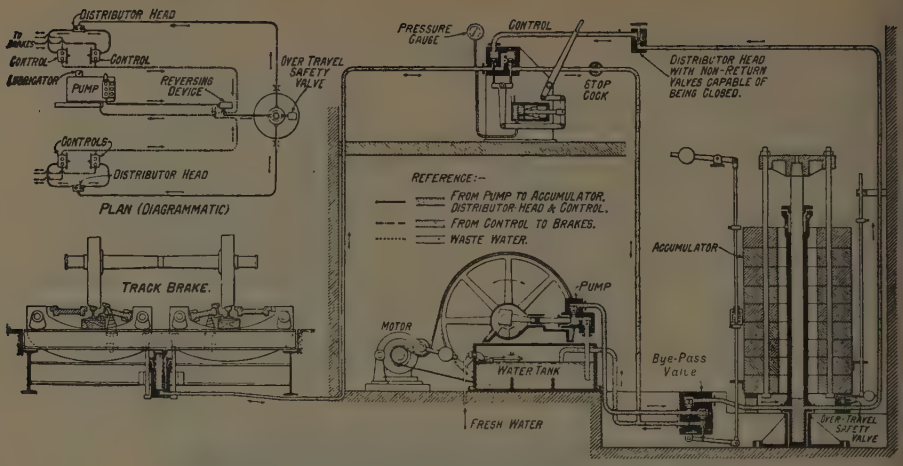


Fig. 7. — Diagram of the hydraulic and braking systems.

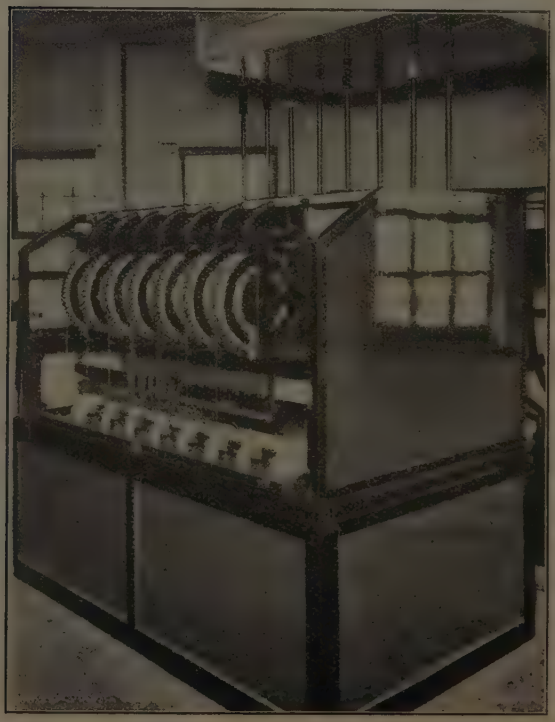


Fig. 8. — The collector-drum locking frame in which the switch movements are stored.

length, the signalman controlling the outlet is advised of its approach so that he may release it with a minimum of delay.

A wheel and tire difficulty.

The many different types of wheels and tires in use in England offer a problem in designing and constructing the retarders so that all shapes and sizes can be suitably retarded. Certain adjustments are still being made at Whitemoor in this respect. Unfortunately, there is a small proportion of cars on which the tires are secured to the wheel centers by means of bolts, and these cannot be handled by the retarders, but are passed through the retarder in the non-braking position and into track No. 31, which is provided especially for these cars. At present, therefore, additional men have to be employed for braking purposes, but this difficulty is receiving careful consideration. At the entrance to the receiving yard a device has been installed to detect and indicate such wheels as are fitted with projecting fastenings that make retarder control impossible.

Aside from this difficulty with certain wheels, little trouble has been experienced. Lack of uniformity in the thickness of the wheels has little effect on the retardation. The number of axles, also, has no influence on the braking efficiency.

Mechanical and electrical apparatus.

Reference has already been made to the fact that the hydraulic car retarders and switches are operated from a central tower located near the base of the hump. The top floor of this tower is surrounded by a window set at an angle so that an excellent view is obtained of the yard, hump, retarders and receiving tracks. The controllers for actuating the two groups of retarders are mounted in pairs to the left and right of the center of the floor and the men operating them are each provided with a cut-card for use when a train is being sorted. A switchboard in table form is located near the middle of the control room for setting the electrically operated and also the manually operated switch machines. This switchboard or table has immediately in front of it a number of levers for setting the switches for a complete train coming down the hump from the receiving tracks, one setting being all that is necessary.

On the intermediate floor is an apparatus known as a collector-drum locking frame, consisting of seven collector drums, one for each set of automatic switches. The eight levers located in front of the switchboard connect with rods extending downward to this frame, whereby, through a system of cam-and-lever motions, the collector drums are operated. This stores up all switch movements in the collector drums, each of which consists of an inner and outer drum locked together magnetically The outer drum has a row of studs around it, and the setting-up operation puts these studs in or out, depending upon the arrangement of switches that is desired. The inner drum carries a switch arm, which is operated by the studs in the outer drum. As the car passes down the hump the inner drum is made to turn one notch for each car or set of cars, by means of track circuiting, which also automatically sets the switches for the next car.

On receipt of the cut card, to which reference was made in dealing with the traffic operations, the automatic points are set by the operator. The lever connected with the required group of sidings is depressed, and this operates the drums which control the switches over which the cars must pass. As an example : If a car is intended for No. 40 track in groupe « A » the movement of the group « A » lever would set automatic points Nos. 1 and 2. The next

car may possibly be for No. 1 track in group « H ». The operator accordingly depresses lever « H » and so on, all this being done prior to the commencement of the switching of the train. The switches beyond the automatic ones are electrically operated under hand control. In setting them the operator has the cut card before him on the switchboard and sets the points for the whole train by depressing the levers in the proper sequence. A bell rings when the drums have made a complete revolution and are full.

When all the movements are thus stored up and the first cut, corresponding to the movement last stored in the collector drums, is pushed over the hump, the track circuits and relays, situated at each automatic switch layout, release the inner drum, which through the effect of a counterweight, rotates one notch at a time concentric with and relative to the now-stationary outer drum; and a switch lever, which may or may not be moved, according to whether the peg in the outer drum is depressed or left in its normal position, either operates the switch or leaves it in its former position.

Each collector drum can store up movements for 50 cuts, and an automatic device is provided for locking the frame should this number be reached; in this event, however, the remainder can be stored up while the train is being shunted, without affecting the working of the control machine.

The top or face of the switchboard is practically a replica of the yard itself, there being a number of metal bars corresponding to the 40 tracks, with movable pieces corresponding to the switch points. The operator moves these to operate the switches as required by the cuts. A series of small electric lamps light up automatically, and show which way the points are set. These lights are extinguished as the cars pass over the switch points, lighting up again as they clear a given point, and this keeps the operator informed of the movements of the cars.

The control of the hydraulic cylinders for actuating the retarder brakes is vested in two operators, each controlling one set of mechanism for each pair of retarders. A lever working over a toothed sector controls the hydraulic pressure or flow. Each control apparatus is fitted with a gage for showing the pressure, which is varied by the position of the operating lever from 0 to 100 atmospheres, thus varying the pressure in the retarder levers.

Retarder details.

There are four retarders, located on the four main ladders leading to the classification tracks; they are operated by four control levers in the control cabin. The retarders each consist of a table which can be raised and lowered by means of several hydraulic cylinders. Dr. Frölich's « weight automatic » principle is one of the important technical features, and insures that the weight of the car will automatically establish and control the braking effect while the car is passing through the retarder.

The under-structure, which is about 50 feet long and 10 ft. 4 in. wide, rests in a concrete pit, and carries the running rails, which are of B. S. R. 90-lb. flatbottom section. This under-structure is supported by the hydraulic cylinders, which are placed longitudinally in the center. Each cylinder is fitted with a piston which carries a cross beam and in turn supports two cradles. These cradles, carrying the retarder rails proper, are free to move sideways, being provided with rocking segments for this purpose. Of these rails, the outer one is fixed rigidly to the cradle and the inner one is pivoted in such a manner that when hydraulic pressure is applied to the cylinders, the cross beam, and with it the cradles, rises to a maximum

height which brings the top of the braking rails about 4 3/4 inches above the level of the running rail and alongside the car wheels.

It will thus be seen that if the retarder rails are raised in this manner when a car is passing through, the foot of the inner retarder rail is raised until it meets the flange of the wheel, and any further pressure forces the head of this rail against the inside flange of the tire, bringing the outer retarder rail against the other side and thus providing the desired degree of retardation.

If the pressure is still further increased, the car will simply be lifted off the running rail, and will continue to run on the flanges of its wheels, which are wedged between the braking rails, the maximum retardation being then in force. This precludes the possibility of derailment. The downward thrust causes the inner and outer brake rails to function as a toggle joint, causing pressure to be exerted on either side of the tires.

The hydraulic pressure is obtained from a reservoir which is housed in the basement of the control cabin and charged by a special triple-throw hydraulic pump driven by a 20-H. P. motor. Between each retarder and its respective control handle there is only one pressure pipe. The pressure applied to the retarder is regulated by the control handle. The maximum hydraulic pressure which can be applied to the cylinders of the rail brakes is about 1 400 lb. per square inch, which, working on a 5 29/32-inch piston, is sufficient to raise the heaviest car from the running rails, thereby subjecting it to the maximum retardation.

The control handle can perhaps best be described as a spring-loaded automatic pressure-relief valve, and its method of working is as follows : By moving the lever across its quadrant the pressure is admitted to the pipe leading to the brake and the latter is raised to the full extent. The position of the lever sets the pressure at which the release valve will lift, in such a manner that if the handle is, say, only halfway across when the car enters the retarder, a certain amount of water is released back through the control valve, which results in the table falling somewhat, and applying half the maximum retardation. If, however, the handle is pushed completely over, and consequently no water is released by the valve, the retarder rails remain in the highest position and the maximum retardation is applied.

The concrete pits in which the brakes are located are provided with heating pipes, which are connected to a hot-water boiler in the control cabin. This method of heating proved entirely satisfactory during severe weather, and no trouble whatever was caused by pipes freezing up. The retarder rails are sufficiently flexible to take up the difference of gage between different pairs of axles, and the cradles enable differences in gage from tire to tire to be taken up without variation of the braking effort applied. The retarder rails are capable of adjustment, and are reversible.

Switch operation.

The operation of the switches is, as already intimated, partly automatic and partly non-automatic. All switches are controlled by one man at a switch table in the control cabin. The switch motors operate on 110 volts d. c., the collector-drum circuits on 36 volts, and the track circuits on 12 volts.

The first seven switches, that is to say, the three between the hump and the retarders, and the four immediately following the retarders, are automatically operated by reason of the cars shunting the track circuits and relays. The movements of the automatic switches having been set up prior to the shunting of the train, by means of the eight

route levers situated in the front of the switch table, the classification of a complete train proceeds rapidly and without interruption.

The position and length of the track circuits are somewhat critical, being of necessity in the nature of a compromise. The effective length is about 38 feet, which is divided into two parts, one of 13 feet ahead of the switch point, and one about 22 1/2 feet behind it. The fixing of the total length at 38 feet precludes the possibility of using a car the distance between axles of which is more than 38 feet. If it were longer it would reduce the speed at which switching could be done.

When the car, or cut of cars, enters the first section of insulated rail, a relay is operated which locks the points and lights up the occupation indicator on the switch table. The second section operates the second relay, which is a so-called « stick-up » relay in parallel with the first. The main object of this « stick-up » relay is to avoid the premature release of a relay and consequent moving of the switches owing to temporary high resistance from rail to rail, such as is sometimes caused by dirt or sand. When the last axle leaves the second insulated section, the collector drum moves around and the point is moved, or left in its last position, as the case may be, for the next cut.

The insulated portion in front of the point is of just sufficient length that at 16 miles per hour, the maximum speed attainable by any car, the switch point, which operates in less than three-quarters of a second, is enabled to complete its movement before the wheel can reach the point of the switch.

[*Railway Signalling* is indebted to the *Railway Gazette*, London, for the information in this article.]

[313 : 625 .143.5]

Statistics of rail breakages during the year 1929.

In accordance with the resolution passed at the London Congress, 1925 (1), we publish the tables hereafter giving the information which has been sent in by the adherent administrations on the subject of the breakages of rails which occurred on their systems during the year 1929.

For the sake of simplification and unless stated otherwise :

Light rails applies to rails of a weight less than 85 lb. per yard (42.5 kgr. per metre).

Medium rails, to rails of 85 to 105 lb. per yard (42.5 to 52.5 kgr. per metre).

Heavy rails, to those weighing 106 lb. per yard (53 kgr. per metre) or over.

(1) See *Bulletin of the Railway Congress*, March 1926, p. 240.

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles	More than 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	*Maximum axle load*
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
ARGENTINE.		Miles.			Miles.			Miles.			Miles.			Miles.		English tons.
Buenos Ayres and Pacific Railway.																
Light rails	...	...	...	...	...	...	...	...	...	...	...	...	37	1 143.9	20.21	12.8 to 18.7
Medium rails	1	1 881.7	0.33	2	1 881.7	0.66	1	1 881.7	0.33	2	1 881.7	0.66	4	1 881.7	1.32	18.7 and 21.2
Total. . .	1	1 881.7	0.33	2	1 881.7	0.66	1	1 881.7	0.33	2	1 881.7	0.66	41	3 025.6	8.47	...

Number of train-miles : 10 219 673.
Total number of fractures : 47.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 28.57.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Central Argentine Railway.		Miles.			Miles.			Miles.			Miles.			Miles.		English tons.
Light rails	...	...	...	...	...	...	...	...	...	...	...	...	4	357.8	6.9	16.7
Medium rails	4	614.1	4.05	2	290.3	4.28	4	163.7	15.2	5	1 514.2	2.06	...	703.2	...	16.7
Total. . .	4	614.1	4.05	2	290.3	4.28	4	163.7	15.2	5	1 514.	2.06	4	1 061.0	2.35	...

Number of train-miles : 14 130 393.
Total number of fractures : 19.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 8.36.

PERCENTAGE OF BREAKAGES IN THE RESPECTIVE PORTIONS OF THE RAILS COVERED BY AND CLEAR OF THE FISHPLATES.

DESCRIPTION OF RAILS.	Percentage of breakages.	AGE OF RAILS : Less than 5 years.	5 to 10 years.	10 to 15 years.	15 to 20 years.	Over 20 years.	Percentage for total number of breakages.
Central Argentine Railway (*continued*).							
Light rails	In joints	...	...	...	...	25 %	25 %
	Clear of fishplates.	...	...	...	...	75 %	75 %
Medium rails	In joints	25 %	...	25 %	40 %	...	26.67 %
	Clear of fishplates.	75 %	100 %	75 %	60 %	...	73.33 %

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years.			5 to 10 years.			10 to 15 years.			15 to 20 years.			More than 20 years.			*Maximum axle load*
	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	
Cordoba Central Railway.	We do not keep our records of rail breakages in the form required by the resolution of the London (1925) Congress and therefore, we regret we are unable to supply the data requested.															

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS.	Length of single track with each rail profile.	Age of rails : 5 years and less.						6 to 10 years					
		Year of manufacture.	Number of fractures: In the length of the rail.	Number of fractures: At the joint.	Number of fractures: Total.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Year of manufacture.	Number of fractures: In the length of the rail.	Number of fractures: At the joint.	Number of fractures: Total.	Length of single track of this class.	Number of fractures per 1 000 km.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Miles.					Miles.						Miles.	
BELGIUM													
Belgian National Railway Company.													
Light rails :													
Weight : 38 kgr. (76.60 lb. per yard), profile adopted in 1863 (steel) and given up since.	100.6	...	...	...	...	...	...	...	...	...	...	...	...
Weight : 40.65 kgr. (81.94 lb. per yard), profile adopted in 1898 and given up since.	1 364.8	1925	...	...	...	71.0	...	1920 to 1924	2	...	*2*	252.9	4.1
Medium rails :													
Weight : 50 kgr. (100.79 lb. per yard), profile adopted in 1910.	2 322.9	1925 to 1929	3	20	*23*	1 256.6	11.3	1920 to 1924	12	29	*41*	631.1	40.7
Weight : 52 kgr. (104.82 lb. per yard), profile adopted in 1886 and given up since.	184.2	...	...	...	...	...	...	...	...	...	...	...	...
Heavy rails :													
Weight : 57 kgr. (114.90 lb. per yard), profile adopted in 1907 and given up since.	270.3	...	...	...	...	...	...	...	...	...	...	...	...
Total. . .	4 242.8	...	3	20	*23*	1 327.6	...	...	14	29	*43*	884.0	...

Number of English tons (gross) hauled, passengers and goods : 20 113 382 500.

Number of train-miles : 46 331 309.

Total number of fractures : 253 (*35 of which in tunnels*).

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 33.9.

Age of rails :																
10 to 15 years.				Length of single track with profiles of 14 years and more.	Number of fractures per 1 000 kilometres or per 625 miles of these classes.	15 to 20 years.				more than 20 years.				Length of single track with profiles of 15 years and more.	Number of fractures per 1 000 kilometres or per 625 miles of these classes.	Total number of fractures for the whole of the System.	*Maximum axle load.*
	Number of fractures.					Year of manufacture.	Number of fractures.			Year of manufacture.	Number of fractures.						
	In the length of the rail.	At the joint.	Total.				In the length of the rail.	At the joint.	Total.		In the length of the rail.	At the joint.	Total.				
15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
				Miles.										Miles			Pounds.
...	...	...	...	...	...	...	...	...	...	...	2	...	2	100.6	12.3	*2*	
...	...	...	...	...	...	1910 to 1914	[illegible]	3	[illegible]	1898 to 1909	23	36	*59*	1 040.9	40.6	*70*	
19	...	3	*3*	124.3	15.0	1910 to 1914	5	51	*56*	...	...	...	...	310.8	111.9	*123*	44 090
.	...	...	...	...	...	...	...	...	...	1887 to 1908	9	10	*19*	184.2	63.9	*19*	
.	...	...	...	...	...	1910 to 1914	4	16	*20*	1907 to 1909	4	15	*19*	270.3	89.0	*39*	
	...	3	[illegible]	124.3	...	...	15	70	*85*	...	38	61	*99*	1 906.8	...	*253*	

Percentages of fractures :	At the joint.	Outside the joint.
I. *Light rails*	[illegible]5.5	44.5
II. *Medium rails*	79.5	20.5
III. *Heavy rails*	79.5	20.5

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles	5 to 10 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km or per 625 miles	10 to 15 years. Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles	More than 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Maximum axle load
Chimay Railway.	No fractured rail was reported in our main line in 1929.															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
French Nord Railway (Nord Belge Lines).		Miles.			Miles.			Miles.			Miles.			Miles.		English tons.
Light rails	...	...	...	...	...	...	...	3.85	...	...	1.40	...	...	8.16	...	18.2
Medium rails	...	91.88	...	...	17.88	...	...	5.05	...	4	33.50	74	3	37.43	50	19.7
Heavy rails	...	...	...	...	...	...	...	...	...	...	1.37	...	...	0.05	...	19.7
Total. . .	...	91.88	...	...	17.88	...	...	8.90	...	4	36.27	68	3	45.64	40	...

Number of train-miles : 2 256 069.
Total number of fractures : 7.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 19.

PARTICULARS OF THE FRACTURES.

Medium rails

Rails from 15 to 20 years of age :

2 failures at the joint ; new and clean breakage over the whole of the rail section with silvery oval mark. Number of pieces : 2 in each case.

1 failure at the joint ; new and clean fracture over the whole of the rail section without silvery oval mark. Number of pieces : 2.

1 failure at the joint with much rusted old portion in the head, extending to the outer surface of the head. Number of pieces : 2.

Rails over 20 years of age :

1 failure clear of the fishplates ; new and clean breakage over the whole of the rail section with silvery oval mark. Number of pieces : 2.

1 failure clear of the fishplates with much rusted old portion in the foot, extending to the outer surface of the foot. Number of pieces : 2.

1 failure clear of the fishplates with much rusted old portion in the head, extending to the outer surface of the head. Number of pieces : 2.

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Maximum axle load
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Belgian National Light Railway Company.																English tons.
Light rails	1	...	...	2	...	...	...	...	..	...	...	...	716	...	...	9.8
Medium rails	...	...	...	5	...	...	4	...	...	3	...	...	1	...	...	...
Total. . .	1	...	...	7	...	...	4	...	...	3	...	...	717	...	...	...

Number of train-miles : 25 632 000.
Total number of fractures : 732.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 178.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
CONGO COLONY.		Miles.			Miles.			Miles.			Miles.					English miles.
Lower-Congo to Katanga Railway.																
a) **Bukama-Sakania Line.**																
Light rails	7	93.2	47	3	3.1	600	2	202.0	6	18	211.3	53	...	...	...	14.8

Number of train-miles : 1 864 100.
Total number of fractures : 30.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 100.

Notes. — Percentage of fractures : at the joint : 3 = 10 %; outside the joint : 27 = 90 %.
Percentage of breakages according to the appearance of the fracture : *a* – 2 = 14, or 47 %; *b* 1 = 6, or 20 %; *b* – 2 = 10, or 33 %.
Length of line : 820 km. (510 miles).

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
b) Port Francqui-Bukuma Line (L. K. D.)		Miles.			Miles.											English tons.
Light rails	...	573.5	...	...	124.5	...	...	...	...	...	...	...	...	...	...	...

Number of train-miles : 581 000
Total number of fractures : 0.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 0.

Length of line : 698 miles.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
BRAZIL. **Leopoldina Railway.**					Miles.						Miles.			Miles.		English tons.
Light rails :																
20 kgr. (40.3 lb. per yard) . .	...	...	...	...	...	...	...	...	...	...	...	...	103	533.8	119.9	
25 kgr. (50.4 lb. per yard). .	...	...	...	1	257.2	2.4	...	...	...	...	...	...	...	...	...	10.27
32 kgr. 64.5 lb. per yard). .	...	...	...	...	...	...	...	...	...	1	68.4	9.0	5	343.6	9 0	
37 kgr. (74.6 lb. per yard). .	...	...	...	...	...	...	...	...	...	...	...	...	3	588.4	3.1	
Total. . .	...	...	...	1	257.2	2 4	...	...	...	1	68.4	9.0	111	1 465.8	47.0	...

Number of train-miles : 6 173 462.
Total number of fractures : 113.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 113.7.

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Less than 5 years. Length of single track of this class.	Less than 5 years. Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	5 to 10 years. Length of single track of this class.	5 to 10 years. Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures	10 to 15 years. Length of single track of this class.	10 to 15 years. Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	15 to 20 years. Length of single track of this class.	15 to 20 years. Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	More than 20 years. Length of single track of this class.	More than 20 years. Number of fractures per 1 000 km. or per 625 miles.	Maximum axle load
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
CHINA.		Miles.			Miles.			Miles.			Miles.			Miles.		Pounds
South Manchuria Railway Company.																
Light rails	40	11.54	2 153.5	48	35.72	835.1	11	8.26	827.1	10	15.82	392.7	48	29.41	1 014.2	51 235
Medium rails	19	284.26	41.7	172	662.19	161.4	47	59.53	490.6	...	...	...	...	...	...	51 235
Total . . .	59	294.80	124.4	220	697.91	195.9	58	67.79	531.6	10	15.82	392.7	48	29.41	1 014.2	...

Number of train-miles : 8 836 790.
Total number of fractures : 395.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 277.8.

COLOMBIA.

National Railway Company of Colombia.

So far, our outdoor services have not advised us of any rail breakages other than those which occurred during the period of construction or which are due to such causes as derailments, etc ; we have no records of the latter. The requested information will only be available commencing with the next year.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
DENMARK.		Miles.			Miles.			Miles.			Miles.			Miles.		250 lb. for 45 lb. per yard rails. 660 lb. for 64.5 lb. per yard rails. 770 lb. for 74.6 lb. per yard and over.
State Railways.																
Light rails	...	95.4	...	5	106.4	29.4	5	121.8	25.5	6	303.9	12.3	238	685.8	215.6	
Medium rails	1	91.3	6.8	2	167.1	7.4	1	47.0	13.2	...	126.7	...	7	129.3	33.7	
Total . . .	1	186.7	3.3	7	273.5	15.9	6	168.8	22.1	6	390.6	8.7	245	815.1	186.8	

Number of train-miles : 14 608 900.
Total number of fractures : 265.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 112.7.

DESCRIPTION OF RAILS.	Total number of fractures.	A				B												
		Percentage of fractures at the joint		outside the joint		a) 1.		a) 2.		b) 1.		b) 2.		c)		d) Number of pieces rails broken into		
		number	per-centage	number	per-centage	number	per-centage	number	per-centage	number	per-centage	number	per-centage	number	per-centage	two pieces	three pieces	four pieces
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Danish State Railways (*continued*).																		
Light rails.	254	197	77.6	57	22.4	8	3.2	104	40.9	37	14.6	54	21.3	51	20.0	238	16	0
Medium rails.	11	5	45.6	6	54.4	1	9.1	5	45 6	1	9.1	3	27.3	1	9.1	8	2	1
Total. . . .	265	202	76.2	63	23 8	9	3.4	109	41.2	38	14.3	57	21.5	52	19.6	246	18	1

A. — Percentage of fractures in the respective portions of the rails *covered by* and *clear of* the fishplates.

B. — Percentage of fractures according to the appearance of the section :

a) Fresh and clean fracture through the whole of the rail section : 1. With silvery oval mark ; 2. Without silvery oval mark.

b) Fractures, part of which is old and much rusted, extending to the outer face of the foot or head of the rail :

1. Rusted part in the foot ;
2. Rusted part in the head.

c) Fractures with much rusted portion not extending to the outer surface of the foot or head of the rail.

d) Number of pieces into which the rail is broken.

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years.			5 to 10 years.			10 to 15 years.			15 to 20 years.			More than 20 years.			Maximum axle load
	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
East of Zealand Railway.														Miles.		Pounds.
Light rails	...	...	...	...	...	...	...	...	...	...	...	...	5	29.2	...	20 720
Number of train-miles : 179 770. Total number of fractures : 5.																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
South Funen Railway.		Miles.			Miles.			Miles.						Miles.		
Light rails	1	21.7 (approx.)	29	...	5.0 approx.	...	1	18.6 (approx.)	33	..	...	...	67	83.9 (approx.)	496	...
Number of train-miles : 885 740. Total number of fractures : 69																
Number of fractures per 10 000 000 train-kilometres or 6 250 000 train miles : 484.																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
EGYPT. State Railways.		Miles.			Miles.			Miles.			Miles.			Miles.		English tons.
Light rails	[illegible]	...	...	[illegible]	...	...	[illegible]	...	...	[illegible]	...	...	10	767	12.9	18.85
Medium rails	2	467.3	2.66	1	187.7	3.31	...	69.6	...	3	236.1	7.87	15	342	27.32	18.85
Total . .	2	467.3	2.66	1	187.7	3.31	...	69.6	...	3	236.1	7 87	31	1 109	17.37	...
Number of train-miles : 12 574 330. Total number of fractures : 37.																
Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 18.28.																

TYPE OF RAILS.	On the straight.		On curves.		*Remarks.*
	Number.	Age.	Number.	Age.	
1	2	3	4	5	
EGYPT.					
State Railways (*continued*).					
	1	1	...	...	
	1	2	...	...	Rail in crossing.
Flat bottom, 47 kgr. (94.7 lb. per yard)	1	9	...	...	Stock rail.
	2	16	...	...	
	1	18	...	...	Stock rail.
	6	22	...	...	3 stock rails.
Flat bottom, 46 kgr. (92.7 lb. per yard)	...	...	1	22	
	7	23	...	...	4 stock rails.
	1	26	...	...	
	1	26	...	...	
	1	27	...	...	Stock rail.
	...	...	1	27	
Flat bottom, 42 kgr. (84.7 lb. per yard)	1	28	...	...	
	1	30	...	...	
	1	33	...	...	
	1	23	...	...	Rail in crossing.
Unsymmetrical, 42 kgr. (84 7 lb. per yard)	1	26	...	...	
Flat bottom, 40 kgr. (80.6 lb. per yard)	2	24	...	...	1 rail in crossing.
	1	32	...	...	
Flat bottom, 37.4 kgr. (75.4 lb. per yard)	1	37	...	...	
	1	41	...	...	
	1	40	...	...	
Flat bottom, 36 kgr. (72.6 lb. per yard)	1	41	...	...	
	1	48	...	...	

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Less than 5 years. Length of single track of this class.	Less than 5 years. Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	5 to 10 years. Length of single track of this class.	5 to 10 years. Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures	10 to 15 years. Length of single track of this class.	10 to 15 years. Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	15 to 20 years. Length of single track of this class.	15 to 20 years. Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	More than 20 years. Length of single track of this class.	More than 20 years. Number of fractures per 1 000 km. or per 625 miles.	Maximum axle load
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
SPAIN.		[Miles.]												Miles.		English tons.
Andalusian and South of Spain Railways.																
Light rails	...	...	...	...	...	...	...	...	...	...	...	...	And. 142 South 91	663 187	...	...
Medium rails	And. 3	148	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Number of train-miles : { And. : 4 708 490. South : 1 304 510.

Total number of fractures : { And. : 145. South. : 91.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : { And. : 191.35. South. : 433.46.

1 **Central Aragon Railway.**	No broken rails in 1929. Number of train-miles : 923 675.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
											Miles.					English tons.
Madrid, Saragossa and Alicante Railways.																
Medium rails :	...	...	...	...	...	...	...	...	...	2	509	2.44	...	...	...	17.7

Number of train-miles : 19 5'8 620.
Total number of fractures : 2.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 0.65.

Particulars of the fractures, according to the appearance of the section.

(*Madrid, Saragossa and Alicante Railways*).

A. Percentage of failures at the joint (that is to say in the part of the rail covered by the fisnplate) and outside the joint.		*B*. Percentage of failures according to the appearance of the section.					
		a) New clean fracture over the whole section of the rail.		*b*) Fracture partly old and rusted extending to the outer surface of the flange or head of the rail.		*c*) Fracture with old and rusted surface not extending to the exterior surface of the flange or of the head of the rail.	*d*) Number of pieces into which the rail was broken.
At the joint.	Outside the joint.	1. With silvery oval mark.	2. Without silvery oval mark.	1. Rusted surface in the flange of the rail.	2. Rusted surface in the head of the rail.		
...	100.0	...	...	...	100.00	...	2

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles	5 to 10 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles	10 to 15 years. Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles	15 to 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles	More than 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles	Maximum axle load
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
North of Spain Railway.		Miles.			Miles.			Miles.			Miles.			Miles.		Pounds
Light rails	...	...	...	...	...	...	...	...	...	2	845	1.470	72	845	52.920	...
Medium rails.	10	2 018	3.080	8	2 018	2.464	3	2 018	0.924	5	2 018	1.540	2	2 018	0.616	...
Total. . .	10	...	...	8	...	...	3	...	...	7	...	...	74	...	...	...

Number of train-miles : 21 021 975.
Total number of fractures : 102.

Number of fractures per 10 000 000 train kilometres or 6 250 000 train-miles : 30.14.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Great Southern of Spain Railway. (Concessionnaire of Lorca to Baza and Aguilas Lines).														Miles.		Pounds
Light rails	1	...	...	...	...	...	...	...	...	...	...	...	18	123	91	30 645

Number of train-miles : 440 142.
Total number of fractures : 19.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 254.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
UNITED STATES OF AMERICA. Baltimore and Ohio Railroad.		Miles.			Miles.			Miles.			Miles.			Miles.		Pounds
100-lb. per yard rails.	282	1 510.38	117	194	958.23	126	168	603.58	174	135	358.10	236	41	163.07	157	70 000
130-lb. per yard rails.	124	984.00	70	16	144.70	69	...	...	...	...	...	...	...	...	...	70 000
Total. . .	406	2 494.98	102	210	1 102.93	119	168	603.58	174	135	358.10	236	41	163.07	157	...

Particulars of the fractures.

100-lb. rails.	Less than 5 years. — 1 510.38 track miles — 282 breaks.	5 to 10 years. — 958.23 track miles. — 194 breaks.	10 to 15 years. — 603.58 track miles. — 168 breaks.	15 to 20 years. — 358.10 track miles. — 135 breaks.	More than 20 years. — 163.07 track miles. — 41 breaks.	*All 100-lb. broken rails.* — 3 593.36 track miles. — 820 breaks.
A. Clear breaks, outside limits of fishplates	29 — 10.3 %	26 — 13.4 %	26 — 15.5 %	22 — 16.3 %	3 — 7.3 %	106 — 12.9 %
B. Transverse fissures, outside limits of fishplates	182 — 64.5 %	73 — 37.6 %	34 — 20.2 %	62 — 45.9 %	— — —	351 — 42.8 %
C. Vertical breaks, inside limits of fishplates	10 — 3.5 %	23 — 11.9 %	19 — 11.3 %	3 — 2.2 %	10 — 24.4 %	65 — 7.9 %
D. Diagonal breaks through web and rail head, inside limits of fishplates	61 — 21.7 %	72 — 37.1 %	89 — 53.0 %	48 — 35.6 %	28 — 68.3 %	298 — 36.4 %
Total. . . .	282 — 100.00 %	194 — 100.00 %	168 — 100.00 %	135 — 100.00 %	41 — 100.00 %	820 — 100.00 %

130-lb. rails.	Less than 5 years. — 124 breaks.	5 to 10 years. — 16 breaks.
A. Clear breaks, outside limits of fishplates	9 — 7.25 %	1 — 6.25 %
B. Transverse fissures, outside limits of fishplates	82 — 66.13 %	7 — 43.75 %
C. Vertical breaks, inside limits of fishplates	3 — 2.42 %	3 — 18.75 %
D. Diagonal breaks through web and rail head, inside limits of fishplates .	30 — 24.20 %	5 — 31.25 %
Total.	124 — 100.00 %	16 — 100.00 %

Note. — In practically all cases the oval spots or transverse fissures are in the head. Our records do not permit a separation as between those that are oxidised and those that are not.

The following rail failures were excluded from the above tables. These failures are such as did not interrupt the continuity of the running surface and include crushed heads, split heads, piped rails, split webs and broken bases.

130-lb. rails with less than 5 years service	14
130 lb. — — 5 to 10 years service	148
Total. . .	162

100-lb rails with less than 5 years service	206
— — — 5 to 10 years service	102
— — — 10 to 15 — —	62
— — — 15 to 20 — —	52
— — — more than 20 years service	26
Total. . .	448

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Less than 5 years. Length of single track of this class.	Less than 5 years. Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	5 to 10 years. Length of single track of this class.	5 to 10 years. Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures	10 to 15 years. Length of single track of this class.	10 to 15 years. Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	15 to 20 years. Length of single track of this class.	15 to 20 years. Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	More than 20 years. Length of single track of this class.	More than 20 years. Number of fractures per 1 000 km. or per 625 miles.	*Maximum axle load.*
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Delaware and Hudson Railroad.		Miles.			Miles.			Miles.			Miles.			Miles.		Pounds
Medium rails	93	330	176	67	195	142	21	70	187.5	18	34	333	4	77	32.5	75 000

Number of train-miles : 6 278 220.
Total number of fractures : 203.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 202.062.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Illinois Central System. *		Miles.			Miles.			Miles.			Miles.					Pounds
90-lb. per yard, A. R. A.-A.	349	1 641	133	669	2 086	200	794	830	590	418	619	422	...	...	...	63 700
110-lb. per yard, R. E. . .	28	361	48	—	...	...	...	...	...	...	...	...	...	...	...	63 700
Total. . .	377	2 002	117	669	2 086	200	794	840	590	418	619	422	..	...	...	...

Number of train-miles : 38 611 161.
Total number of fractures : 2 258.

Number of fractures per 10 000 000 train kilometres or 6 250 000 train-miles : 366

Percentage of breakage . . . . . { Covered by fishplates . . . . . 9.70; Clear of fishplates . . . . . 90.30; With silvery oval spot . . . . . 27.10; Without silvery oval spot 72.90

* Year ending on 31 October 1929.

1	2	3 Miles:	4	5	6 Miles.	7	8	9 Miles.	10	11	12 Miles.	13	14	15 Miles.	16	17 English tons.
Kansas City Southern Railway.																
Medium rails	1	182.4	3.4	13	200.9	40.4	22	114.2	120	16	129.8	77.1	39	195.4	199.5	63 500
Heavy rails	...	23.2	...	...	...	...	...	...	...	...	...	...	...	...	...	63 500
Total. . .	1	205.6	3.0	13	200.9	40.4	22	114.2	120	16	129.8	77.1	39	195.4	199.5	...

Number of train-miles : 3 447 841.
Total number of fractures : 91.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 165.

1	2	3 Miles.	4	5	6 Miles.	7	8	9 Miles.	10	11	12	13	14	15	16	17 Pounds
Lehigh & New England Railroad.																
Medium rails	3	33	57	...	39	...	13	53	153	...	...	...	...	...	...	73 000
Heavy rails	3	13	144	...	...	...	...	...	...	...	...	...	...	...	...	73 000
Total, . .	6	46	81	...	39	...	13	53	153	...	...	...	...	...	...	...

Number of train-miles : 537 040.
Total number of fractures : 19.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 221.1.

1	2	3 Miles.	4	5	6 Miles.	7	8	9 Miles.	10	11	12 Miles.	13	14	15	16	17 Pounds. Steam locomotives: 68 000. Electric locomotives: 75 000.
Norfolk & Western Railway.																
100-lb. per yard	5	113	27.7	9	374	15.0	5	305	10.2	...	212	...	...	...	...	
130-lb. per yard	28	1 072	16.3	6	372	10.1	...	...	...	...	...	...	...	...	...	
Total. . .	33	1 185	17.4	15	746	12.6	5	305	10.2	...	212	...	...	...	...	

Number of train-miles : 15 440 901.
Total number of fractures : 53.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 21.3.

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	*Maximum axle load.*
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		Miles.			Miles.			Miles.			Miles.			Miles.		Pounds
Pennsylvania Railroad.																
Light rails :	...	...	...	...	1 00	...	...	1.00	...	...	3.32	...	18	466.05	24.14	76 100
Medium rails :	107	840.97	79.52	180	854.94	131.59	830	1 215.96	420.62	904	1 595.99	354.01	1370	3 420.50	250.33	78 500
Heavy rails :	315	4 179.69	47.1	385	1 978.46	121.62	299	938.98	199.02	24	30.65	489.39	...	8.37	...	78 500
Total. . .	422	5 020.66	52.53	565	2 834.40	124.51	1129	2 155.94	327.29	928	1 629.96	355.84	1388	3 894.92	222.77	...

Number of train-miles : 118 151 815.
Total number of fractures : 4 432.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 234.5.

PENNSYLVANIA RAILROAD (*continued*).

	Fractures		Broken into								
	In joint. %	Silvery oval spot. %	2 pieces. %	3 pieces. %	4 pieces. %	5 pieces. %	6 pieces. %	7 pieces. %	8 pieces. %	11 pieces. %	12 pieces. %
Light rails :	38.8	...	88.8	11.2	...	...	...	...	...	...	...
Medium rails :	73.8	11.3	87.9	10.2	1.5	0.2	0.04	0.06	0.03	0.03	0.01
Heavy rails :	60.5	24.6	92.3	7.0	0.5	0.1	...	...	...	...	0.1
All rails.	70.5	14.3	88.9	9.5	1.2	0.2	...	0.1	...	...	0.1

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years.			5 to 10 years.			10 to 15 years.			15 to 20 years.			More than 20 years.			Maximum axle load
	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Reading Company.																
Medium rails.	...	...	...	9	...	...	8	...	...	5	...	...	3	...	...	...
Heavy rails	46	...	...	34	...	...	3	...	...	...	...	...	...	...	...	...
Total. . .	46	..	...	43	...	...	11	...	...	5	...	...	3	...	...	...

Total number of fractures : 108.

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	*Maximum axle load.*
1	2	3	4	5	6	7	8	9	10	11	12	13	13	15	16	17
Richmond, Fredericksburg and Potomac Railroad.		Miles.			Miles.											Pounds
Medium rails	...	...	..	7	124	35	...	...	...	...	...	...	...	...	...	70 000
Heavy rails	4	104	24	...	...	...	...	...	...	...	...	...	...	...	...	70 000
Total . .	4	104	24	7	124	35	...	...	...	...	...	...	...	...	...	...

Number of train-miles : 2 558 000.
Total number of fractures : 11.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 trains-mile : 27.

1	3	4	5	6		8		10	11	12	13	14	15	16	17
Wabash Railway.	Miles.			Miles.			Miles.			Miles.			Miles.		Pounds
Light rails.	...	...	...	...	...	1	1.1	568	46	252.6	113	384	659.95	362	67 750
Medium rails	27	311.10	54	69	381 8	113	50	278.12	113	97	94.9	640	...	...	...	67 750
Heavy rails	19	488.0	24	...	...	...	...	...	...	...	...	...	...	...	...	67 750
Total . . .	46	799.10	36	69	381.8	113	51	279 22	113	143	347.5	254	384	659.95	362	...

Number of train-miles : 16 273 797.
Total number of fractures : 693.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 266.

Number of fractures occurring in splice : 158.
Number of fractures occurring out of splice : 535.

Transverse fissures	128
Horizontal fissures	17
Regular break	458
Split head	20
Bolt hole	22
Broken base	9
Crushed head	39

NAMES ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Less than 5 years. Length of single track of this class.	Less than 5 years. Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	5 to 10 years. Length of single track of this class.	5 to 10 years. Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures	10 to 15 years. Length of single track of this class.	10 to 15 years. Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	15 to 20 years. Length of single track of this class.	15 to 20 years. Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	More than 20 years. Length of single track of this class.	More than 20 years. Number of fractures per 1 000 km. or per 625 miles.	*Maximum axle load.*
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		Miles.			Miles.			Miles.			Miles.			Miles.		English tons.
FINLAND **State Railways.**																
Light rails	873	601	903	36	428	52	10	191	32	9	416	13	220	2 341	58	14.8
Medium rails.	...	94	...	10	106	58	...	79	...	...	...	...	...	...	...	14.8
Total. . .	873	695	780	46	534	53	10	270	23	9	416	13	220	2 347	58	...

Number of train-miles: 12 840 170.
Total number of fractures: 1158.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 560.

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS.	Age of rails :					Length of single track.	Number of fractures per 1000 km. or per 625 miles.	Maximum axle load.
	Less than 5 years.	5 to 10 years.	10 to 15 years.	15 to 20 years.	More than 20 years.			
1	2	3	4	5	6	7	8	9
FRANCE. **State Railways.** (*)						Miles.		English tons.
Light rails	...	...	...	8	130	5 087	16	19.7
Medium rails	26	24	2	7	39	2 626	23	19.7
Heavy rails : Standard 55 kgr. per m. (111.87 lb. per yard).	...	1	...	...	...	53	11	19.7
Total . . .	26	25	2	15	169	...	...	...

(*) Running lines.

Number of train-miles : 43 815 105.

Total number of fractures : 237.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 33.

	Percentage : Covered by the fishplates.
A. — Fractures of light rails.	32.6
— medium	41.8
— heavy	100

	Percentage : Clear of the fishplates.
A. — Fractures of light rails	67.4
— medium	58.2
— heavy.	...

		Light.	*Medium*	*Heavy.*
		Per cent.	Per cent.	Per cent.
B. — *a*) Fresh and clean fracture in the whole of the rail section. . .	with silvery oval mark. . .	5.0	1.0	...
	without silvery oval mark	42.0	42.8	...
b) Fracture, part of which is old and much rusted, extending to the outer surface of the foot or the head of the rail	in the foot.	16.0	21.4	...
	in the head	21.0	14.3	...
c) Fracture, part of which is old and much rusted, not extending to the outer surface of the foot or the head of the rail	. . . . .	13.0	20.5	100

		2 pieces.	3 pieces.	4 pieces.	6 pieces.	8 pieces.
d) Number of pieces into which the rail is broken	light	121	11	2	3	1
	medium. . .	82	11	5	...	...
	heavy . . .	1	...	...	...	...

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	More than 20 years Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	*Maximum axle load*
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Alsace and Lorraine Railways (including the Guillaume-Luxembourg lines).		Miles.			Miles.			Miles.			Miles			Miles.		English tons
Light rails	...	...	...	...	22	...	16	129	77	13	168	48	137	1 166	73	For wagons : 15.7. For locomotives : 18.3.
Medium rails	4	283	9	26	214	75	22	40	344	27	103	163	38	196	120	
Heavy rails	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	
Total . .	4	285	9	26	236	68	38	169	140	40	271	92	175	1 362	80	...

Number of train-miles : 19 855 190.
Total number of fractures : 283.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 89.

Note. — This table does not include broken *machined rails* in points and crossings, that is to say, those of the nose, wing rails, points and stock rails.

	Percentage : Covered by the fishplates.
A. — Fractures of light rails	77.7
— medium	71.8
— heavy	...

	Percentage : Clear of the fishplates.
A. — Fractures of light rails	22.3
— medium	28.2
— heavy	...

		Light.	*Medium.*	*Heavy.*
		Per cent.	Per cent.	
B. — a) Fresh and clean fracture in the whole of the rail section	with silvery oval mark	10.8	14.5	...
	without silvery oval mark	28.3	23.1	...
b) Fracture, part of which is old and much rusted, extending to the outer surface of the foot or the head of the rail	in the foot	10.8	16.2	...
	in the head	18.7	11.1	...
c) Fracture, part of which is old and much rusted, not extending to the outer surface of the foot or the head of the rail		31.4	35.1	...

		2 pieces	3 pieces	4 pieces	6 pieces	7 pieces	13 pieces.
d) Number of pieces into which the rail is broken	light	140	18	8	...	...	...
	medium	82	28	3	2	1	1
	heavy	...	...	...	...	...	...

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Less than 5 years. Length of single track of this class.	Less than 5 years. Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	5 to 10 years. Length of single track of this class.	5 to 10 years. Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures	10 to 15 years. Length of single track of this class.	10 to 15 years. Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	15 to 20 years. Length of single track of this class.	15 to 20 years. Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	More than 20 years. Length of single track of this class.	More than 20 years. Number of fractures per 1 000 km. or per 625 miles.	Maximum axle load.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		Miles.			Miles.			Miles.			Miles.			Miles.		English tons.
Paris Circle Railways. (*)																
Light rails.	...	1.13	...	...	...	...	...	1.94	...	...	15.42	...	2	14.55	85	
Medium rails.	...	68.13	...	1	37.73	16	1	4.46	139	2	5 13	242	1	0.52	1 187	18.9
Heavy rails	...	4.02	...	...	1.29	...	...	...	...	...	...	...	...	...	...	
Total. . .	...	73.28	...	1	39.02	15	1	6.40	97	2	20.55	60	3	15.07	123	

(*) Broken rails in running lines (excluding those in points and crossings).

Number of train-miles : 1 837 045
Total number of fractures : 7.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 23.67.

	Percentage: Covered by the fishplates.
A — Fractures of light rails	100
— medium	80
— heavy	...

	Percentage: Clear of the fishplates.
A. — Fractures of light rails	...
— medium	20
— heavy	...

		Light.	*Medium.*	*Heavy.*
		Per cent.	Per cent.	
B. — a) Fresh and clean fracture in the whole of the rail section	with silvery oval mark	...	...	...
	without silvery oval mark	...	20	...
Fracture, par of which is old and much rusted, extending to the outer surface of the foot or the head of the rail	in the foot	...	...	...
	in the head	50	40	...
c) Fracture, part of which is old and much rusted, not extending to the outer surface of the foot or the head of the rail	in the web	50	40	...

		2 pieces.	3 pieces.	4 pieces.
d) Number of pieces into which the rail is broken	light	2	...	...
	medium	5	...	...
	heavy	...	...	...

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years.			5 to 10 years.			10 to 15 years.			15 to 20 years.			More than 20 years.			Maximum axle load.
	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Est Railway. (*)		Miles.			Miles			Miles.			Miles.			Miles.		English tons.
Light rails	...	40	...	...	63	...	2	151	8.2	...	104	...	220	2 495	54.7	
Medium rails	3	654	2.8	5	313	9.7	5	341	9.2	15	342	27	115	1 315	55.7	18.7 (locomotives).
Heavy rails	...	16	...	...	8.4	...	...	...	...	...	...	...	...	...	...	
Total	3	710	...	5	384.4	8.1	7	492	8.8	15	446	20 9	335	3 810	54.6	

(*) Fractures in running lines, excluding points and crossings.

Number of train-miles : 40 303 920.
Total number of fractures : 365.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 56.2.

	Percentage: Covered by the fishplates.
A. — Fractures of light rails	18.5
— medium	71.8
— heavy	...

	Percentage: Clear of the fishplates.
A. — Fractures of light rails	81.5
— medium	28.2
— heavy	...

		Light.	*Medium.*	*Heavy.*
		Per cent.	Per cent.	
B — *a* Fresh and clean fracture in the whole of the rail section	with silvery oval mark	14.4	10.8	...
	without silvery oval mark	43.7	23	...
b) Fracture, part of which is old and much rusted, extending to the outer surface of the foot or the head of the rail	in the foot	18.4	12.5	...
	in the head	13.5	10.8	...
c) Fracture, part of which is old and much rusted, not extending to the outer surface of the foot or the head of the rail	in the web	10	42.9	...

		2 pieces.	3 pieces	4 pieces.	5 pieces.
Number of pieces into which the rail is broken	light	203	17	1	1
	medium	118	17	6	2
	heavy	...	...	...	...

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Less than 5 years. Length of single track of this class.	Less than 5 years. Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	5 to 10 years. Length of single track of this class.	5 to 10 years. Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures.	10 to 15 years. Length of single track of this class.	10 to 15 years. Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	15 to 20 years. Length of single track of this class.	15 to 20 years. Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	More than 20 years. Length of single track of this class.	More than 20 years. Number of fractures per 1 000 km. or per 625 miles.	Maximum axle load
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Midi Railway. (*)		Miles.			Miles.			Miles.			Miles.			Miles.		English tons.
Light rails	...	4.3	...	...	...	...	...	...	...	14	349	25	83	1 967	26	17.7
Medium rails.	...	364	...	21	486	27	4	235	11	2	31	40	...	...	...	17.7
Heavy rails	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total. . .	...	368.3	...	21	486	27	4	235	11	16	380	26	83	1 967	26	...

(*) Running lines.

Number of train-miles : 21 084 363.
Total number of fractures : 124.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 36.

	Percentage : Covered by the fishplates.
A. — Fractures of light rails	67
— medium	■
— heavy	...

	Percentage : Clear of the fishplates.
A. — Fractures of light rails	33
— medium	7
— heavy	...

		Light.	*Medium.*	*Heavy.*
		Per cent.	Per cent.	
B. — ■ Fresh and clean fracture in the whole of the rail section	with silvery oval mark	11	4	
	without silvery oval mark	43	26	
b) Fracture, part of which is old and much rusted, extending to the outer surface of the foot or the head of the rail	in the foot	9	22	None.
	in the head	14	7	
■ Fracture, part of which is old and much rusted, not extending to the outer surface of the foot or the head of the rail		23	41	

		2 pieces.	3 pieces.	4 pieces.	More than 4 pieces.
d) Number of pieces into which the rail is broken	light	85	5	4	3
	medium	21	4	2	...
	heavy	...	...	...	...

NAME OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years.			5 to 10 years.			10 to 15 years.			15 to 20 years.			More than 20 years.			Maximum axle load
	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Nord Railway.		Miles			Miles.			Miles.			Miles.			Miles.		English tons.
Light rails	...	...	...	...	1	...	6	331	11.3	1	36	17.1	119	718	103	18.5
Medium rails	2	470	2 6	17	369	28.7	1	633	1	19	429	27.5	44	971	28.1	18.5
Heavy rails	...	2	...	...	2	...	...	0.050	...	...	...	...	...	...	...	18.5
Total . . .	2	472	2.6	17	372	28.4	7	964.05	4.5	20	465	26.7	163	1 689	60	...

Number of train-miles : 39 859 790

Total number of fractures : 209.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 33.

	Percentage: Covered by the fishplates.
A. — Fractures of light rails	23
— medium	59
— heavy	...

	Percentage: Clear of the fishplates.
A. — Fractures of light rails	77
— medium	41
— heavy	...

		Light.	*Medium.*	*Heavy.*
		Per cent.	Per cent.	
B. — *a*) Fresh and clean fracture in the whole of the rail section	with silvery oval mark	10.3	8.4	...
	without silvery oval mark	25.4	23.0	...
b) Fracture, part of which is old and much rusted, extending to the outer surface of the foot or the head of the rail	in the foot	27	31.3	...
	in the head	24.6	31.3	...
c) Fracture, part of which is old and much rusted, not extending to the outer surface of the foot or the head of the rail	in the web	12.7	6	...

		2 pieces.	3 pieces.	4 pieces.	5 pieces.	6 pieces.	8 pieces.
d) Number of pieces into which the rail is broken	light	111	9	4	...	1	1
	medium	61	14	5	2	...	1
	heavy	...	...	...	...	...	...

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS.	Age of rails :					Length of single track.	Number of fractures per 1000 km. or per 625 miles.	Maximum axle load.
	Less than 5 years.	5 to 10 years.	10 to 15 years.	15 to 20 years.	More than 20 years.			
1	2	3	4	5	6	7	8	9
Paris-Orleans Railway. (*)						Miles.		English tons.
Light rails	...	...	...	1	35	3 819	5.8	8
Medium rails.	15	13	7	6	41	2 834	17.9	18.7
Heavy rails : Standard [55 kgr. (110.9 lb. per yard)].	...	1	...	...	...	61	9.7	18.7
Total . .	15	14	7	7	76	...	...	...

(*) Running lines.

Number of train-miles : 39 785 640.
Total number of fractures : 119.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 18.5.

	Percentage: Covered by the fishplates.
A. — Fractures of light rails	27.8
— medium	25.7
— heavy	100

	Percentage: Clear of the fishplates.
A. — Fractures of light rails	72.2
— medium	74.3
— heavy	...

		Light.	*Medium.*	*Heavy.*
		Per cent.	Per cent.	Per cent.
B. — a) Fresh and clean fracture in the whole of the rail section	with oval mark	2.8	9.8	...
	without oval mark	36.1	41.5	...
b) Fracture, part of which is old and much rusted, extending to the outer surface of the foot or the head of the rail	in the foot	5.6	14.7	100
	in the head	25.0	17.0	...
c) Fracture, part of which is old and much rusted, not extending to the outer surface of the foot or the head of the rail		30.5	17.0	...

		2 pieces.	3 pieces.	4 pieces.	5 pieces.	6 pieces.	More than 6 pieces.
d) Number of pieces into which the rail is broken	light	33	1	1	...	...	1
	medium	72	5	3	...	2	...
	heavy	1	...	...	...	...	...

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Maximum axle load
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Paris, Lyons and Mediterranean Railway. (*)		Miles.			Miles.			Miles.			Miles.			Miles.		English tons.
Light rails	1	164	3.79	4	165	15.09	...	38	...	7	377	11.55	252	3 534	44.30	18.2
Medium rails	4	972	2.56	60	521	71.60 (1)	6	482	7.73	67	1 343	31.00	160	1 693	58.74	
Heavy rails	...	38	...	3	7	250	...	...	...	...	...	...	...	...	...	
Total. . .	5	1 174	2.64	67	693	60.08 (2)	6	520	7.16	74	1 720	26.74	412	5 227	48.98	

(*) Broken rails, excluding those in points and crossings.

Number of train-miles : 74 684 640.
Total number of fractures : 564.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 46.92

(1) 31 of these in tunnels on 30.7 miles of single line, that is a proportion of 626.26 per 1 000 km. or 625 miles, the proportion of 71.60 being reduced to 36.77 outside tunnels.

(2) 34 of these in tunnels on 41.6 miles of single line, that is a proportion of 507.46 per 1 000 km. or 625 miles, the proportion of 60.08 being reduced to 32.34 outside tunnels.

PARIS, LYONS AND MEDITERRANEAN RAILWAY.

Table I.

	Fractures covered by the fishplates.		Fractures clear of the fishplates.	
	Number.	Percentage.	Number.	Percentage.
Light rails	102	38.65	162	61.35
Medium —	228	76.76	69	23 24
Heavy —	3	100.00	...	...

Table II

	Fresh and clean fractures through the whole of the rail section.		Fractures partly old.	
	Number.	Percentage.	Number.	Percentage.
Light rails	147	55.68	117	44.32
Medium —	188	63.29	109	36.71
Heavy —	3	100.00	...	...

Table III.

	Rails broken into :											
	2 pieces.		3 pieces.		4 pieces.		5 pieces		6 pieces.		7 pieces.	
	Number.	Per-centage.	Number.	Per-centage.	Number.	Per-centage.	Number.	Per-centage.	Number.	Per-centage.	Number.	Per-centage.
Light rails	203	76.90	48	18.18	4	1.51	4	1.51	5	1.90	...	...
Medium —	224	75.75	50	16.83	16	5.39	2	0.68	3	1.01	1	0.34
Heavy —	3	100.00	...	...	...	...	...	...	...	...	...	...

Table IV.

	Fresh and clean fractures through the whole of the rail section.				Fractures with old part extending to the outer surface				Fractures with much rusted old part not extending to the outer surface of the foot or the head.	
	With oval mark.		Without oval mark.		of the foot.		of the head.			
	Number.	Per-centage.	Number.	Per-centage.	Number.	Per-centage.	Number.	Per-centage.	Number	Percentage.
Light rails . .	11	4.17	136	51.51	34	12.88	28	10.61	55	20.83
Medium — . .	20	6 73	168	56.57	40	13.47	16	5.38	53	17.85
Heavy — . .	...	...	3	100.00	...	...	...	...	...	...

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	*Maximum axle load*
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Light Railways of the Landes.											Miles.			Miles.		English tons.
Light rails	...	...	...	...	...	...	...	...	...	...	17	...	26	209	77	14.3
Number of train-miles : 357 670. Total number of fractures : 26.										Number of fractures per 10 000 000 train kilometres or 6 250 000 train-miles : 45.						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Somain-Anzin-Frontière belge Railway.								Miles.								English tons.
Light rails.	...	...	...	...	...	...	1	0.37	1 642	...	...	...	...	...	...	16.9
Number of train-miles : 519 495. Total number of fractures : 1.										Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 12.						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Sud-Ouest Railways.														Miles.		English tons.
Light rails	...	...	...	...	...	...	...	...	...	...	...	...	6	249	15	7.9
Number of train-miles : 559 200. Total number of fractures : 6.																

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
											Miles.			Miles.		English tons.
Ain Departmental Tramways.																
Light rails	...	...	...	...	...	...	...	...	...	2	28	...	...	...	...	7.9
Deux-Sèvres Departmental Tramways.																
Light rails	...	...	...	...	...	...	...	...	...	...	...	...	9	122	40	7.4

Number of train-miles : 246 210
Total number of fractures : 9.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 25.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
					Miles.									Miles.		English tons.
Indre Tramways.																
Light rails	...	...	...	1	0.3	2 000	...	...	...	...	...	...	7	113	38	7.9

Number of train-miles : 253 380.
Total number of fractures : 8.

Number of fractures per 10 000 000 train-kilometres or 250 000 train-miles : 196.

Note. — Completely worn rails in curves have been replaced by rails 5 to 10 years of age.

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	*Maximum axle load.*
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
ALGERIA AND TUNIS.								Miles.						Miles.		English tons.
Algerian State Railways. Algiers District.																
Light rails	...	...	...	...	...	...	...	...	...	...	...	...	2	304	4.08	13.8
Medium rails	...	...	...	...	...	...	4	102	24.39	...	...	...	...	...	...	13.8
Total . .	...	...	...	...	...	...	4	102	24.39	...	...	...	2	304	4.08	...

Number of train-miles : 2 696 000.
Total number of fractures : 6.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 13.829.

A. — Percentage of fractures in the respective portions of the rails :
1. Covered by the fishplates . . . . . 0 %
2. Clear of the fishplates. . . . . 100 %

B. Fractures according to the appearance of the fracture :
a) Fresh and clean fracture through the whole of the rail section :
1. With silvery oval mark . . . . . 0 %
2. Without silvery oval mark. . . . . 50 %

b) Fractures, part of which is old and much rusted, extending to the outer surface of the foot or head of the rail :
1. Rusted part in the foot . . . . . 15 %
2. Rusted part in the head . . . . . 35 %

c Fractures with much rusted portion not extending to the outer surface of the foot or head of the rail . . 0 %

d) Number of pieces into which rails broke . . . . . 2 and 3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		Miles.			Miles.			Miles.						Miles.		English tons.
Bône District.																
Light rails	...	...	...	...	...	...	...	...	...	...	...	...	17	176	59.96	13.8
Medium rails	...	22	...	2	43	28.61	...	32	...	...	...	...	...	...	...	13.8
Total . .	...	22	...	2	43	28.61	...	32	...	...	...	...	17	176	59.96	...

Number of train-miles : 2 004 940.
Total number of fractures : 19.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 58.88.

A. — Percentage of fractures in the respective portions of the rails :

1. Covered by the fishplates. . . . . 21.1 %
2. Clear of the fishplates . . . . . 78.9 %

B – Fractures according to the appearance of the section :

a) Fresh and clean fracture through the whole of the rail section :

1. With silvery oval mark . . . . . 33.3 %
2. Without silvery oval mark . . . . . 66.7 %

b) Fractures, part of which is old and much rusted extending to the outer face of the foot or head of the rail :

1. Rusted part in the foot. . . . . 75 %
2. Rusted part in the head . . . . . 25 %

c) Fractures with much rusted portion not extending to the outer surface of the foot or head of the rail. None.

d) Number of pieces into which the rails broke : 2 for each fracture.

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Maximum axle load
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Constantine District.		Miles.			Miles			Miles.			Miles.			Miles.		English tons.
Light rails	...	58.4	...	...	0.6	...	...	19 3	...	...	106.9	...	5	369.7	8.40	...
Medium rails.	...	8.1	...	...	0.6	...	...	15.5	...	...	...	...	...	...	...	...
Total. . .	...	66.5	...	...	1.2	...	...	34.8	...	...	106.9	...	5	369.7	8.40	...

Number of train-miles : 2 108 035.
Total number of fractures : 5.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 14.738.

A. — Percentage of fractures in the respective portions of the rails :

1. Covered by the fishplates . . . . . 60.4 °/
2. Clear of the fishplates. . . . . 39.6 °/.

B. — Fractures according to the appearance of the section

a) Fresh and clean fracture through the whole of the rail section . . . . . 9.00 °/.

b) Fractures, part of which is old and much rusted, extending to the outer surface of the foot or head of the rail :

1. Rusted part in the foot . . . . . 4.00 °/.
2. Rusted part in the head. . . . . 29.00 °/.

c) Fractures with much rusted portion not extending to the outer surface of the foot or head of the rail. . 58.00 °/.

d) Number of pieces into which the rails broke . 2 for each fracture.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
					Miles.			Miles						Miles.		English tons.
Oran District.																
Light rails.	...	...	...	1	18.6	33.333	1	143	4 347	...	...	...	24	660.5	22.577	10.4

Number of train-miles : 1 989 550.
Total number of fractures : 26.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 81.203.

A. — Percentage of fractures in the respective portions of the rails :

1. Covered by the fishplates . . . . . 3.8 %
2. Clear of the fishplates. . . . . 96.2 %

B. — Fractures according to the appearance of the section :

a) Fresh and clean fracture through the whole of the rail section . . . . . 46.1 %

1. With silvery oval mark
2. Without silvery oval mark

} This information cannot be supplied.

b) Fractures, part of which is old and much rusted, extending to the outer surface of the foot or head of the rail :

1. Rusted part in the foot . . . . . 38.5 %
2. Rusted part in the head. . . . .

c) Fractures with much rusted portion not extending to the outer surface of the foot or head of the rail . . . 15.4 %

d) Number of pieces into which the rails broke :
2 pieces for each rail.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		Miles.			Miles.			Miles.			Miles.			Miles.		English tons.
Paris, Lyons and Mediterranean Railway (Algerian system)																
Light rails.	...	6.2	...	...	111.8	...	...	129.2	...	7	79.5	55	7	399.5	11	16.39
Medium rails.	...	31.2	...	...	23.6	...	...	4.4	...	...	...	...	...	...	...	16.39
Heavy rails.	...	1.2	...	...	...	...	...	...	...	...	...	...	...	...	...	16.39
Total. . .	...	41.6	...	...	135.4	...	...	133.6	...	7	79.5	55	7	399.5	11	...

Number of train-miles : 2 532 000.
Total number of fractures : 14.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 34.

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	More than 20 years Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	*Maximum axle load*
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Tunisian Railway Company.					Miles.			Miles.			Miles.			Miles.		English tons.
Light rails:																
20 kgr. (40.32 lb. per yard) (narrow gauge)	...	...	...	...	...	...	...	...	...	...	...	...	52	113.93	283.607	11.81
25 kgr. (50.40 lb. per yard) (standard gauge) . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	4.57	...	14.76
25 kgr. (50.40 lb. per yard) (narrow gauge)	...	...	...	...	...	...	...	...	...	...	...	...	28	364.40	47.744	11.81
30 kgr. (60.48 lb. per yard) (standard gauge) . . .	...	...	...	...	...	...	...	...	...	...	152.44	...	...	...	...	14.76
30 kgr. (60.48 lb. per yard.) (narrow gauge	...	...	...	...	...	...	...	...	...	...	158.24	...	...	...	...	11.81
34 kgr. (68.54 lb. per yard) (standard gauge) . . .	...	...	...	...	...	...	...	...	...	...	...	...	17	29.99	352.243	14.76
38.20 kgr.(77.01 lb. per yard) (standard gauge) . .	...	...	...	...	20.84	...	1	107.51	5.779	...	...	...	...	...	...	14.76
Medium rails:																
46 kgr. (94.21 lb. per yard standard gauge) . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14.76
Total. . .	...	...	...	...	20.84	...	1	107.51	5.779	...	310.68	...	97	512.89	117.517	...

Number of train-miles : 3 355 262.
Total number of fractures ; 98.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles ; 181,492.

Particulars of the fractures.

DESCRIPTION OF RAILS.	Covered by fishplates.	Clean and new breakage over the whole of the rail section.		Fracture with much rusted old part extending to the outer surface of the foot or head		Fracture with much rusted old part not extending to the outer surface of the foot or the head of the rail.	Number of pieces the rails broke into :	*Remarks.*
		with silvery oval mark.	without silvery oval mark.	in the foot.	in the head.			
1	2	3	4	5	6	7	8	
Tunisian Railway Company (*continued*).								
Light rails :								
20 kgr. (40.32-lb per yard), narrow gauge, over 20 years of age.	15.384	...	...	...	...	28.846	2 pieces.	
25 kgr. (50.40-lb. per yard), narrow gauge, over 20 years of age.	14.285	...	...	...	...	32.142		
34 kgr. (68.54-lb. per yard), standard gauge, over 20 years of age.	29.411	...	...	...	...	41.176		
38.2 kgr. (77.01-lb. per yard), standard gauge, 10 to 15 years.	...	...	...	...	...	1.000		

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails : Less than 5 years.			5 to 10 years.			10 to 15 years.			15 to 20 years.			More than 20 years.			*Maximum axle load*
	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
COLONIES AND PROTECTORATES. AFRICA.					Miles.											English tons.
Morocco Railway Company.																
Light rails	...	...	...	4	408	6.088	...	...	...	...	...	...	...	...	...	19.7

Number of train-miles : 1 254 480.
Total number of fractures : 4.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 19.81.

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Less than 5 years. Length of single track of this class.	Less than 5 years. Number of fractures per 1 000 km. or per 625 miles.	5 to 20 years. Number of fractures.	5 to 20 years. Length of single track of this class.	5 to 20 years. Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	More than 20 years. Length of single track of this class.	More than 20 years. Number of fractures per 1 000 km. or per 625 miles.	FRACTURES. Covered by the fishplates. Number.	Covered by the fishplates. Percentage.	Clear of the fishplates. Number.	Clear of the fishplates. Percentage.	APPEARANCE OF THE FRACTURES. Fresh and clean fracture in the whole of the rail section. with silvery oval mark.	Fresh and clean fracture in the whole of the rail section. without silvery oval mark.	Fracture, part of which is old and much rusted. extending to the outer surface of the foot or the head of the rail. RUSTED PART. in the foot. Number.	in the foot. Percentage.	in the head. Number.	in the head. Percentage.	not extending to the outer surface of the foot or the head of the rail. Number.	not extending to the outer surface of the foot or the head of the rail. Percentage.
1	2	3	4	5	6	7	8	9	10	11	1	13	14	15	16	17	18	19	20	21	22
								Miles.													
Colonial Railways in French West Africa																					
***a*) Thiès to the Niger.**																					
Vignole, 20 kgr. (40.32 lb. per yard), 6 m. (19 ft. 8 1/4 in.) long.	...	...	...	...	...	...	49	343.6	88.60	5	10.20	44	89.79	1	1	39	79.59	5	10.20	3	6.12
Vignole, 25 kgr. (50.40 lb. per yard), 8 m. (26 ft. 3 in.) long.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Vignole, 26 kgr. (52.41 lb. per yard).	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total. . .	...	...	...	...	...	...	49	343.6	88.60	5	10.20	44	88.79	1	1	39	79.59	5	10.20	3	6.12

Maximum axle load : 10.8 English tons.

Number of train-miles : 1 434 870.
Number of fractures per 10 000 000 train-kilometres or 250 000 train-miles : 212.21.

***b*) Conakry to the Niger.**

25 kgr. (50.40 lb. per yard) rails. — No fractures in 1929.

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Less than 5 years. Length of single track of this class.	Less than 5 years. Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	5 to 10 years. Length of single track of this class	5 to 10 years. Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures.	10 to 15 years. Length of single track of this class.	10 to 15 years. Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	15 to 20 years. Length of single track of this class.	15 to 20 years. Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	More than 20 years. Length of single track of this class.	More than 20 years. Number of fractures per 1 000 km. or per 625 miles.	Maximum axle load
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
c) Ivory Coast Railway.		Miles.			Miles.			Miles. Over 10 yaers.								English tons.
Light rails :																
Vignole, 19 ft. 8 1/4 in. long	...	...	...	...	...	...	...	182.69	...	...	...	...	...	...	...	Golwé engines: 11.8 per axle. 13.7 when fully loaded.
Vignole, 26 ft. 3 in. long	...	...	...	...	16.53	...	...	16.16	...	...	...	...	...	...	...	
Vignole, 32 ft. 9 3/4 in long	...	...	...	..	1.80	...	...	...	...	...	...	...	...	...	...	
Standard, 26 ft. 3 in. long	...	...	...	...	12.68	...	...	...	...	...	...	...	...	...	...	
Standard, 39 ft. 4 1/2 in. long	1	21.84	...	...	51 83	...	...	...	...	...	...	...	...	...	...	
German Reparations	...	42.87	...	...	...	...	...	...	...	...	...	...	...	...	...	
Weight per metre (per yard): Vignole, 25.5 kgr. (51.4 lb.) Standard, 26.1 kgr. (52.6 lb.) German, 30 kgr. (60.5 lb.)																
Total	1	64.71	...	...	82.84	...	...	198.85	...	...	...	...	...	...	...	...

Number of train-miles : 572 880.

Total number of fractures : 1.

French Dahomey Railway Company.

No broken rails in 1929.

Number of train-miles : 149 410.

No broken rails were reported in 1929 on the Central Dahomey, the East Dahomey and the Abomey-Bohicon-Zagnanado lines.

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Maximum axle load
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
INDO-CHINA								Miles.			Miles.			Miles.		English tons.
Indo Chinese Colonial Railways.																
Light rails	...	...	...	...	...	...	...	25	...	1	188.9	3.20	27	588.4	28.51	10.5

Number of train-miles : 2 282 625.
Total number of fractures : 28

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 51.72.

Characteristics of the fractures.	Number of fractures.	Percentage.
A. — Fractures in the respective parts :		
1. Covered by the fishplates.	6	21.42
2. Clear of the fishplates	22	78.58
B. — *a*) Fresh and clean fracture in the whole of the rail section :		
1. With oval mark	12	42.85
2. Without oval mark	2	7.14
b) Fracture, part of which is old and much rusted, *extending* to the outer surface of the foot or the head of the rail :		
1. Rusted part in the foot	14	5.00
2. Rusted part in the head	...	...
c) Fracture, part of which is old and much rusted, *not extending* to the outer surface of the foot or the head of the rail	...	...

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Age of rails: Less than 5 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	5 to 10 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	10 to 15 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	15 to 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	More than 20 years. Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Maximum axle load
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		Miles.									Miles.			Miles.		English tons.
French Indo-China & Yunnan Railway Company.																
Light rails	...	18.35	...	...	...	...	...	...	...	3 broken, 14 cracked.	215.38	8 broken, 40 cracked.	5 broken, 15 cracked	296.33	10 broken, 31 cracked.	10.6

Number of train-miles : 1 711 812.
Total number of fractures : 8 rails broken ; 29 cracked.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 29 fractures ; 105 cracks.

Note — The statistics of rail breakages for the year 1929 wil be concluded in the May, 1931 number of the Bulletin.

NEW BOOKS AND PUBLICATIONS.

[656. 25 (0.2 (.73)]

AMERICAN RAILWAY ASSOCIATION, SIGNAL SECTION. — **American railway signaling. Principles and practices.** — New York, N. Y. — Published by the Signal Section, A. R. A., 30, Vesey Street. — 4 pamphlets (8×6 inches), illustrated : Chapter IX, Rectifiers, including fundamental theory of alternating currents (78+20 pages). Chapter XII, Semaphore signals (72+14 pages). Chapter XIII, Light signals (38+10 pages). Chapter XVIII, Electro-pneumatic interlocking (54+16 pages). (Price : Each pamphlet, 25 cents to members and railroad employees ; 35 cents to non railroad employees).

All readers of the *Bulletin* are acquainted with the American Railway Association. We devoted to it in the July 1922 issue, a short note describing its origin and its development. This organisation, a powerful one thanks to the importance of the resources the member railways place at its disposal, and also to the great abilities of the people it can bring together, is in a position to carry out scientific investigations on a very wide scale. Its influence in the technical progress of American railway practice has been considerable.

The publications of the American Railway Association are always of great interest, and the reason is that they are the work of specialised sections which occupy themselves within well defined limits with questions dealing with a particular branch of railway operation, and which are often investigated by committees or sub-committees of the sections. Amongst these sections, that dealing with signalling deserves mention owing to its activity, which is shown at the present time by the publication under the title given above of a series of pamphlets each containing an article on a group of apparatus or installations.

We have already called the attention of our readers to pamphlet VI : Continuous Current Relays (see the November 1927 *Bulletin*). The following is a short review of four pamphlets recently issued.

Chapter IX. — *Rectifiers,* including fundamental theory of alternating currents.

Alternating current is being more widely used in signalling.

To insure continuity of service in case of interruption of supply and to supply the continuous current circuits, a battery of primary cells or accumulators must be provided.

The rectifier is used to recharge the battery by transforming the alternating current into unidirectional pulsating current.

It can also be used to help the load on a primary battery, thereby much prolonging the life thereof.

At the present time rectifiers of different kinds are available : mercury, gas, mechanical (vibratory), electrolytic and copper-oxide. The pamphlet gives particulars of the principle of the functioning as well as describing these rectifiers.

An appendix gives the theory of alternating currents which covers the fundamental notions relating to inductive circuits.

A detailed questionnaire brings out the theoretical and practical knowledge required by the staff responsible for installing and maintaining the apparatus.

Chapter XII. — *Semaphore signals.*

This pamphlet deals with semaphore signals operated by fluid pressure. The systems in use are the electro-pneumatic,

the gas-electric, and the all-electric. The last is the most developed and is described in detail.

The description of the motor equipment (motors, holding devices, etc.) is completed with illustrations, either photographs or drawings for the different applications : continuous current or alternating current, semaphores with one or more arms, or of one or two off positions. Very clear diagrams show the electrical operating and control circuits. Designs are also given of the whole equipment : posts, arms, transmission lines, lamps, lenses, etc.

Very full instructions are given on the erection of the apparatus, on the tests to be made, and on service maintenance.

Chapter XIII. — *Light signals.*

Light signals have advantages over signals with arms which led to some American railways preferring them for new installations, or for renewals, these advantages being the little room occupied, their simplicity, and the fact that they give the same indication by day as by night.

As every one knows, there are light signals using coloured lights, those with position lights, and the mixed system.

The different parts and their erection are described whilst considering in turn the three systems. Typical diagrams of the electrical circuits are shown.

The relays which in this application form the essential operating device, have been fully dealt with in pamphlet No. 5.

The lamps have to satisfy special requirements. They are given a careful examination, curves being given showing the influence of the voltage on their life, candle power, and efficiency.

Chapter XVIII. — *Electro-pneumatic interlocking.*

This title is applied to power installations in which the apparatus on the track is fitted with compressed air cylinders, the inlet and exhaust valves of which are operated by electro-magnets.

The main control equipment is, however, purely electrical and can equally well be used when the points and switches and signals are operated electrically. Whether the motor be pneumatic or electric, the control circuits are electric.

The book gives a detailed description with perspective views of a signal lever and a points lever.

The mechanical interlocking between the levers and the electric interlocking circuits are dealt with in other sections, this one only covering in the case of the track equipment, the operation of the points. Very clear diagrams and drawings illustrate the operating and control circuits of the motors and mechanisms which are used to transmit the movement to the points and to control their position and the difficulties experienced.

As in the other pamphlets, very detailed instructions with a questionnaire are included in this one.

E. M.